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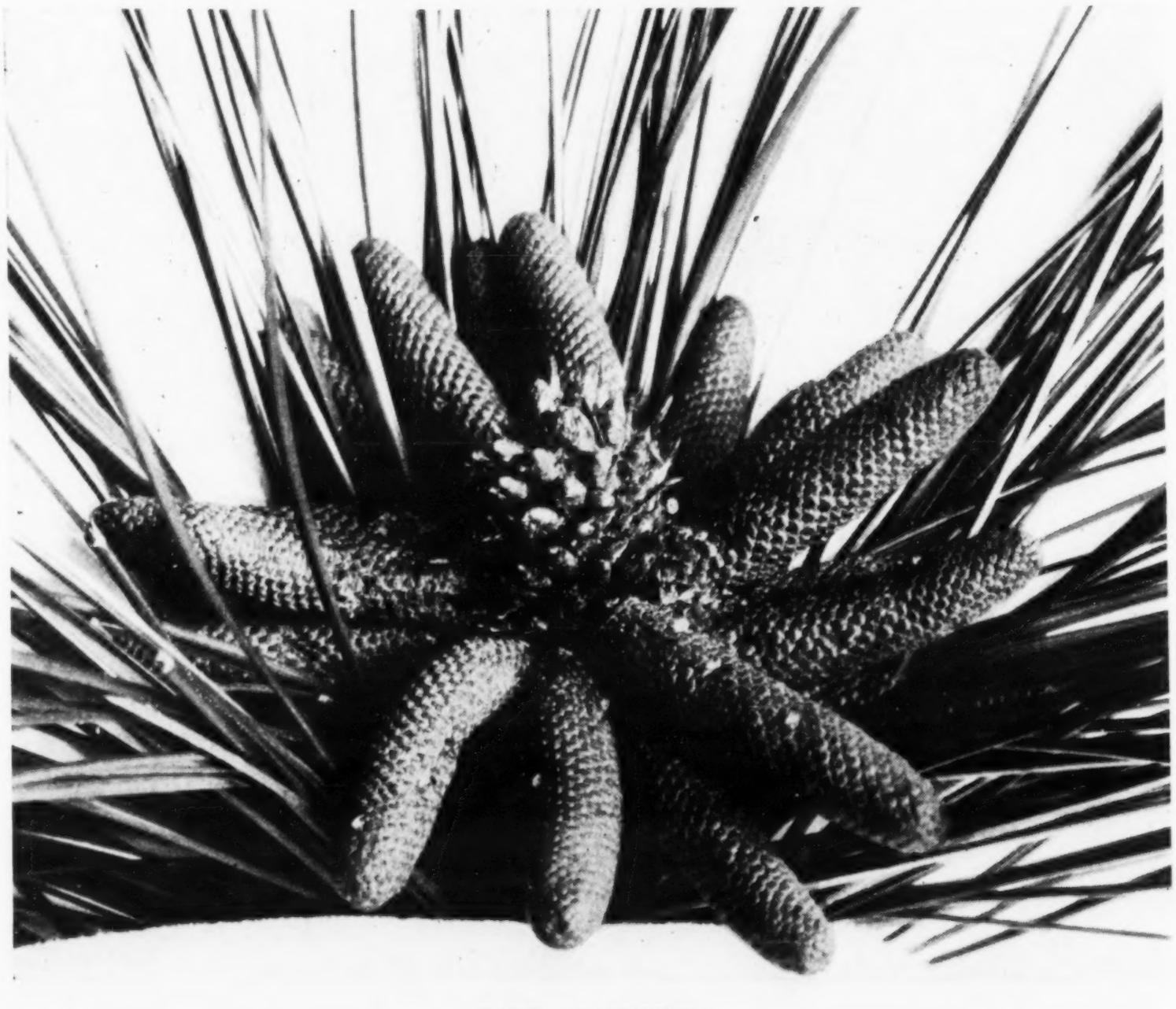

PINE "CATKINS"

See "Breeding Pines for More Rapid Growth"

Crime, Heredity, and Environment

Linked Characters Discovered in the Fowl

A New Seedless Grape

JULY, 1928 Vol. 19, No. 7

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POLLINATING A LARGE WESTERN YELLOW PINE

Frontispiece

Close inspection of this interesting photograph will reveal the man working at the very top of the tree, which is 77 feet high, and 26 inches in diameter at a height of 4½ feet. The numerous white paper bags used to protect the female flowers may be seen scattered over the upper third of the tree.

BREEDING PINES FOR MORE RAPID GROWTH

LLOYD AUSTIN
Director, Eddy Tree Breeding Station, Placerville, California

THIS country has been gradually awakening to the imperative need for replacing its forests which have dwindled down to such an extent that at the present time the virgin timber left in the United States is only one sixth of the original virgin forest area. It is becoming apparent that the wood supply of the future must come more and more from second-growth forests. Under favorable conditions Nature is herself reestablishing the new forests to replace the ones that have been cut; but under many adverse conditions a new forest can only be obtained by actual planting. In certain instances the stand produced by natural reseeding is so irregular and so slow in coming in, that it is preferable to use reforestation measures. Then too, it seems quite probable that an important part of the timber supply of the future will come from small but numerous farm woodlot plantings, which in the aggregate will total a large acreage.

It is clear, then, that man-planted, and quite likely man-maintained plantations of forest trees are destined to play an important rôle in restocking our forest areas. As the forests begin to come under the care of man, the problem arises (as it has arisen in the past, whenever man has brought under cultivation some new crop) as to what kind shall be planted. Are the wild, native forms entirely suitable? Or are they lacking in certain desired characteristics? Certainly such has proven to be the case with the majority of the plants now being grown, whether for food, ornament or for fiber. Almost all of the present crops and garden flowers have been developed from the inferior wild types by breeding or selection. It is natural then, that some thought should be given to the need for breeding work with forest trees. Mr. James G. Eddy, a lumberman of Everett, Washington, was one of the first to recognize this need, and as a result, he established the Eddy Tree Breeding Station in the spring of 1925. He felt that one of the principal drawbacks to the planting of forest trees is the comparatively slow rate at which they normally develop. Hence one of the main objects of the work of the Station is the development of fairly hardy, rapid growing strains of trees that will reach merchantable size in a shorter time and that will have wood of good quality. Secondary consideration is also being given to the matter of developing strains that might tend to produce clearer, stronger, or more durable lumber.

The Experimental Station

After a search over a large part of the Pacific Coast for a suitable location, the site finally selected is a tract of 65 acres of land located about three miles from Placerville, California. Here was found a wonderful combination of favorable conditions. The Station is situated near the lower edge of the main Western Yellow Pine timber belt, in the central Sierras, at an elevation of about 2,700 feet. All timber species typical of the lower Sierras (including Western Yellow pine, Sugar pine, Douglas fir, White fir, and Incense Cedar) are to be found on the Station grounds or nearby. It is in the center of a belt of the most rapid growing Western Yellow line *(Pinus ponderosa)* to be found in California, or elsewhere, as far as is

at present known. The Station is so located that the climate is comparatively mild, making it possible to grow many exotic species that will not stand severe climates. The average growing season at Placerville, is unusually long for the timber belt, being 205 days according to a 25-year average of U. S. Weather Bureau data. This gives a period of nearly seven months without killing frost, which is the same as the growing season in north central Alabama. Of the other factors that were instrumental in reaching a decision as to the best location for the Station, the most important were soil, topography, and water supply. The Station soil is a deep loose sandy loam of a remarkably uniform character. An even and unbroken topography also contributes toward making conditions very much alike over the whole area.

The character "vigor" is a most difficult one to study from the point of view of heredity, for it is, to a greater extent than almost any other character, affected by varying environmental conditions. It is, therefore, of first importance, in nursery and arboretum experiments, to take every reasonable precaution to keep conditions over the whole area as uniform as possible. Figure 1 shows the experimental nursery.

The field work of pollination and cone collection is largely in the hands of the Station Forester, Mr. John S. Barnes, while the nursery and arboretum are under the supervision of the Propagator, Mr. H. M. Lumsden.

While for the first year, work was divided among a large number of different kinds of forest trees, attention is now being concentrated primarily upon the numerous species of pines, which are thought to be the most important of the softwoods Secondary attention is being directed to the hardwoods, and among these walnuts have been chosen as having the greatest possibilities for a strain capable of quick development and possessing wood of high intrinsic value.

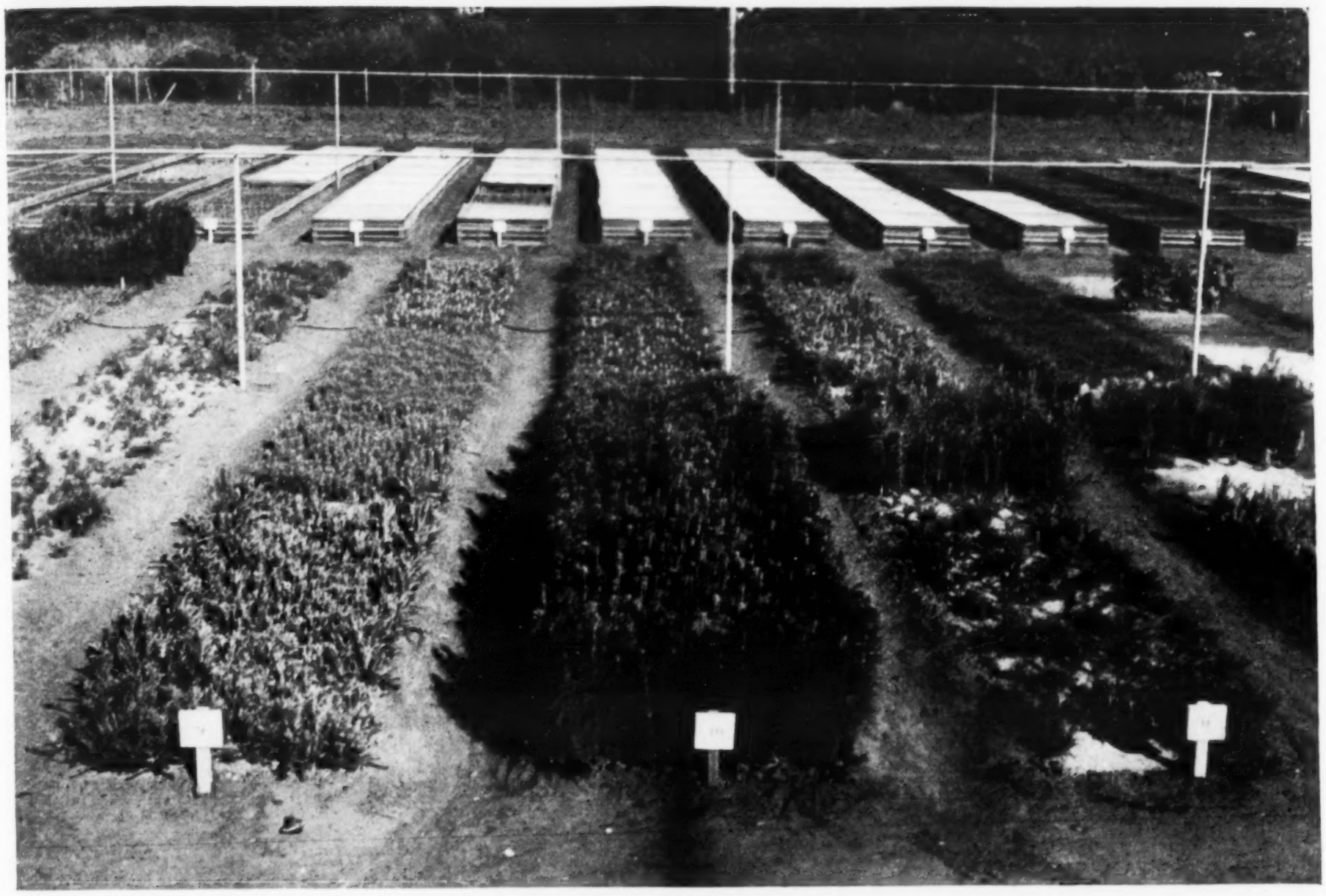
Outline of Methods Being Employed

A. *Method of Selection*—(Finding and perpetuating the best that *Nature* has produced).
   I Finding the fastest-growing *species* (Species Tests).
   II Finding the fastest-growing *geographical* races of the important species (Geographical Race Tests).
   III Finding the fastest-growing *individuals* of the important species, from which to start superior new strains. These individuals that are inherently rapid growing may either be trees in the forest, or seedlings in a nursery.
      (a) Forest trees—Individuals in the forest that are hereditarily superior may be found by either of the following methods:
         (1) Tree Selection.
         (2) Progeny Tests.
      (b) Nursery Seedlings (Nursery Selections).

B. *Methods of Pollination*—(Artificially producing improved types by hand pollination).
   I Crossing Species.
      (a) To secure hybrid vigor.
      (b) To combine the good qualities now occurring in two or more species.
   II Crossing Geographical Races.
   III Crossing Especially Fine Individual Trees of a Species.
   IV Self-pollination (Inbreeding).
      (a) To increase the accuracy of the Progeny Test method.
      (b) To segregate the tree "population" of certain species into types which will gradually approach pure lines.
      (c) To fix desirable characters that may be found.

Tests of Species and Geographical Races.

Pines occur naturally in almost every country of the northern hemis-



THE NURSERY OF THE EDDY TREE BREEDING STATION

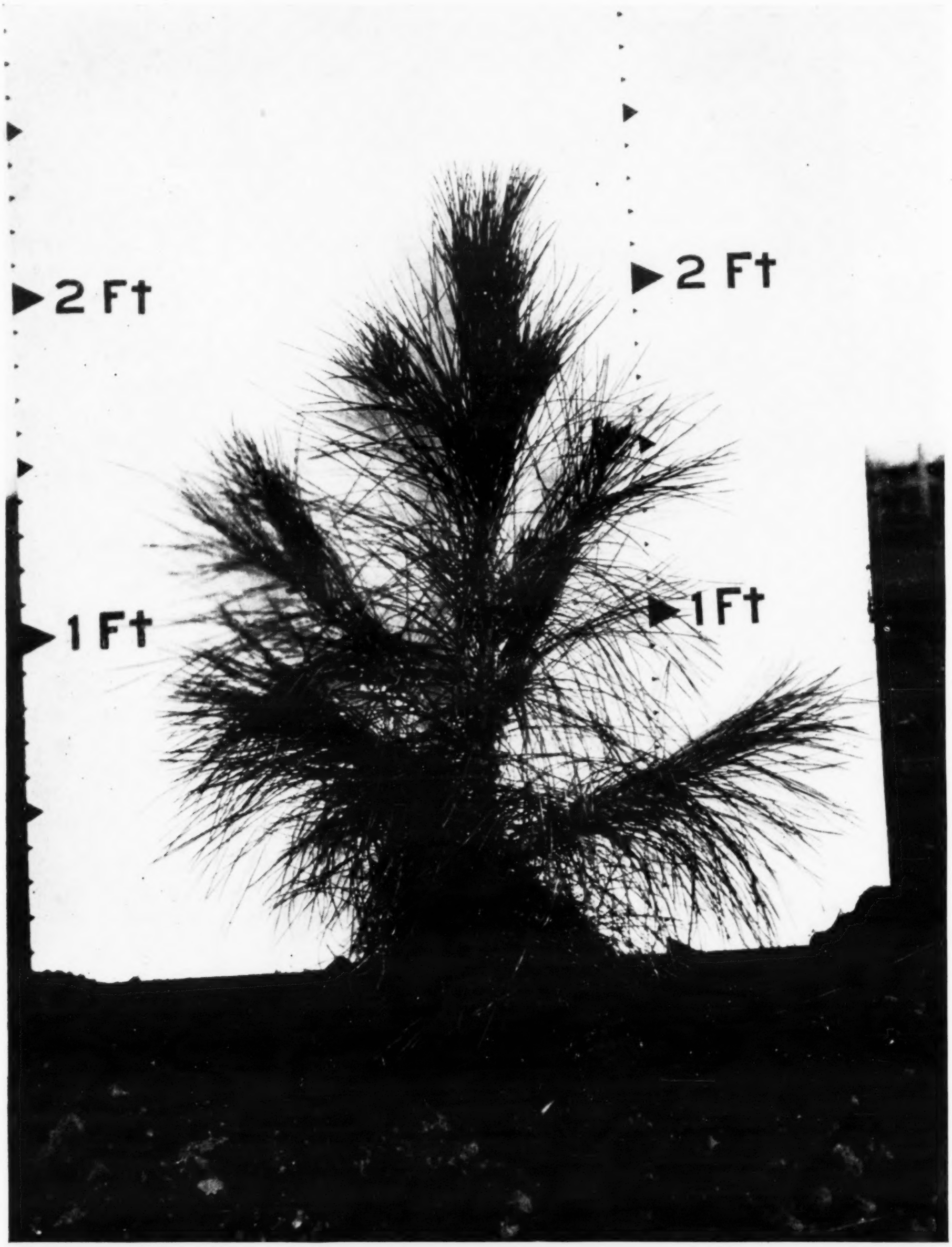
Figure 1

Notice the sprinkling lines over the open beds of two year old seedlings in the foreground, and the enclosed beds of one year old seedlings in the background. The three beds in the immediate foreground contain, from left to right, Redwood, Monterey pine, and Western Yellow pine. The tallest of the two year old Monterey pines are just three feet high.

phere, and there are many species concerning which very little is known about their rate of growth, quality of wood, hardiness, etc. It is proposed to make thorough nursery and arboretum tests of all known species of pines under various conditions. It seems quite possible that some species will be discovered that are adaptable to important forest areas in this country and that will produce wood faster than any now being grown here. There are known about 120 species and fairly important varieties of pines, and of these, seed has already been secured of 87 different kinds. This has come from no less than 40 countries in various parts of the world.

A refinement of the Species Test method is that of studying and isolating the geographic or climatic races that are known to occur in most, if not all, of the species having a fairly wide distribution.

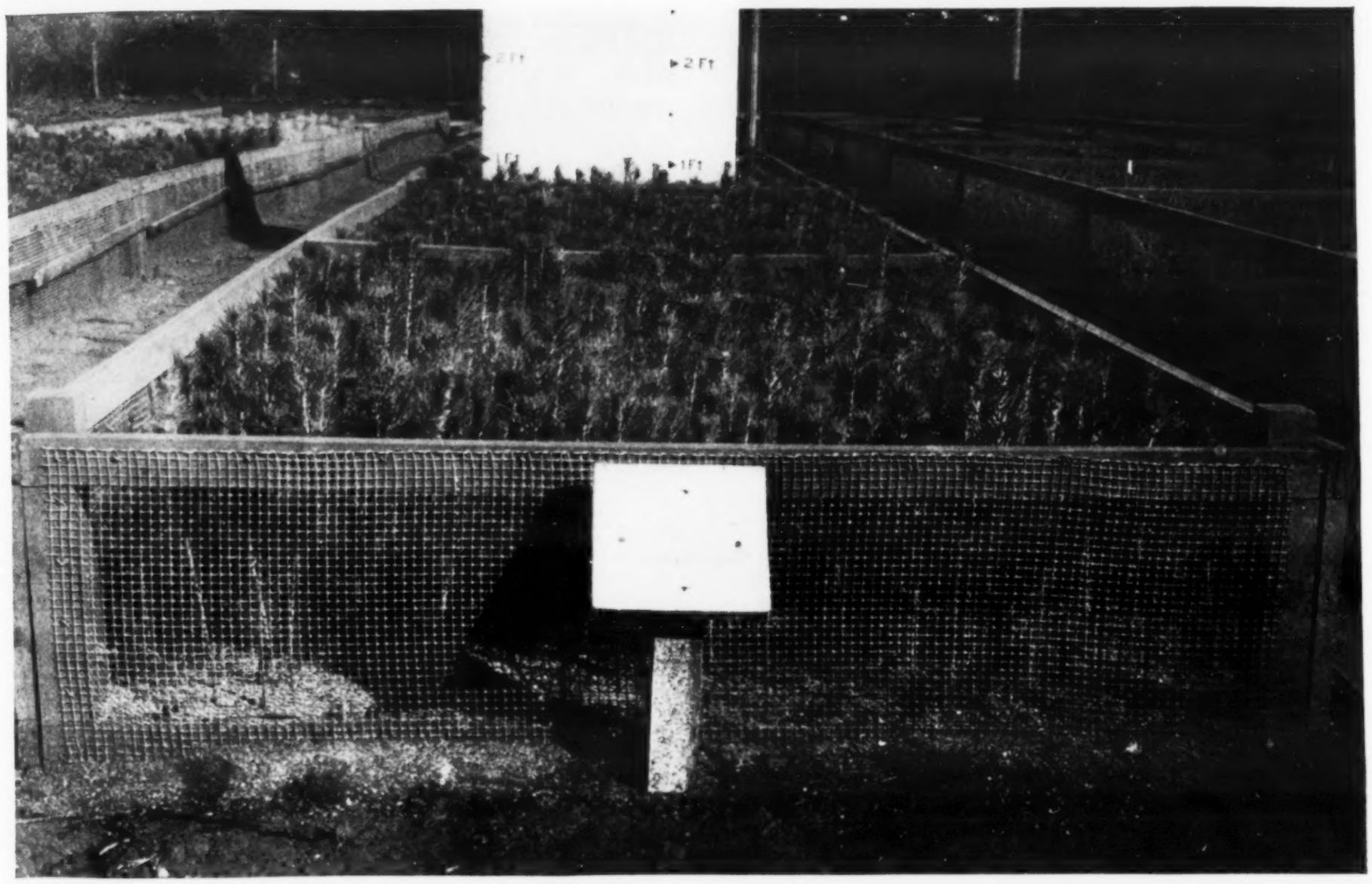
To date, experiments in this direction undertaken by the Station have been confined principally to a study of the geographic races of Western Yellow pine, although the tests are being gradually enlarged to include other species, particularly the four important pines of the Southern states. In order to "kill two birds with one stone" an endeavor has been made to secure the seed from individual trees in each locality. In this way the tests will serve not only as "Geographical Race Tests" but also as "Progeny Tests," to be described farther on. Already there are growing in the nursery Western Yellow pine seedlings from separate trees in British Colum-



A TWO-YEAR-OLD SEEDLING OF PINUS SONDEREGGERI

Figure 2

This rapid growing hybrid seedling pine is only two years old. It grew from a seed of *Pinus palustris* (Longleaf pine) that was probably wind-pollinated with *P. taeda* (Loblolly pine). It occurred in a seedbed of Longleaf pine seedlings, the rest of which were only about an inch high. The Longleaf pine does not normally start its height growth until the fourth or fifth year.



SEEDBED OF SLASH PINE

Figure 3

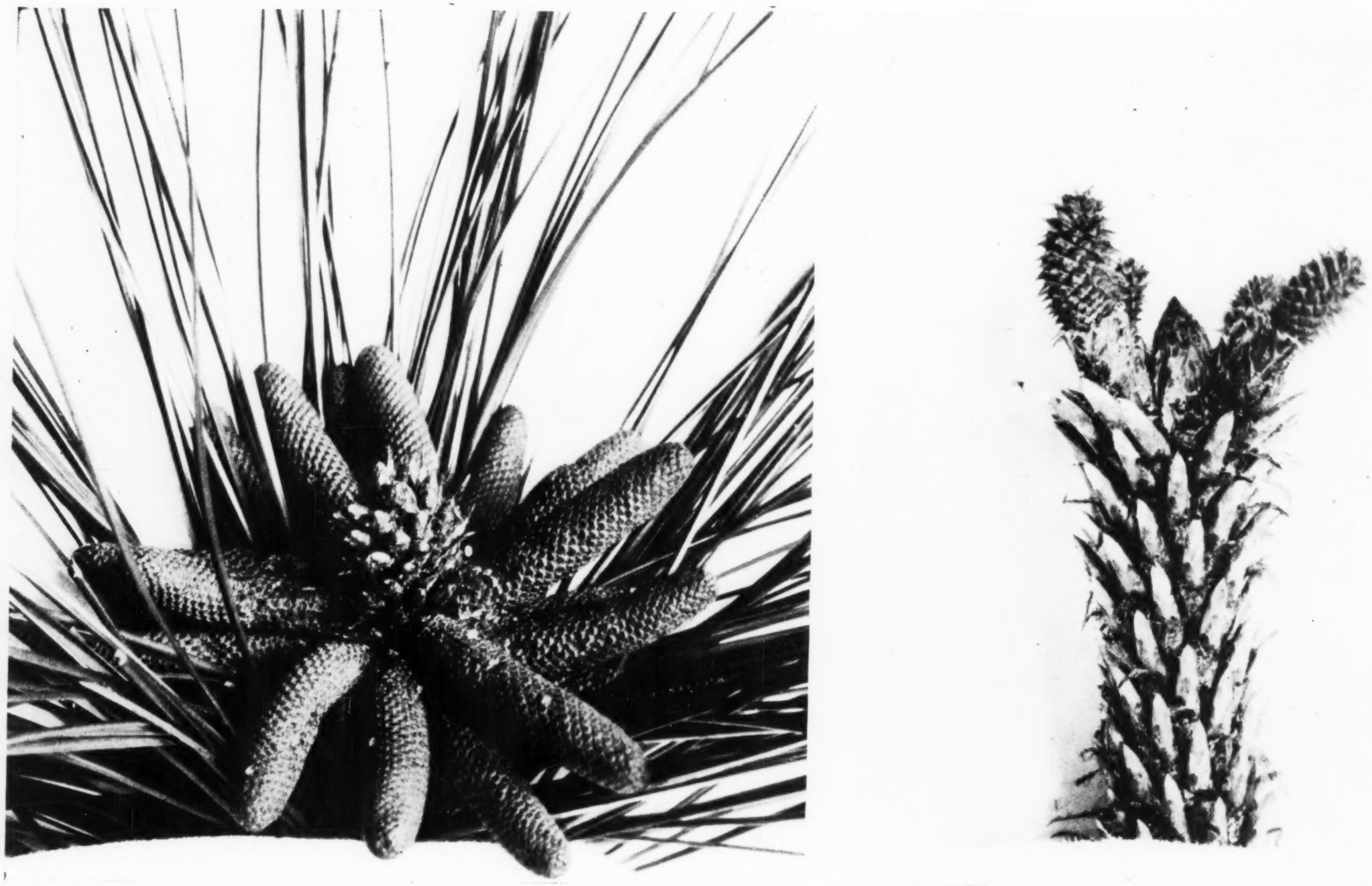
These one-year-old seedlings of *Pinus caribaea* are nearly a foot high. This species, which is native to the Southern States, is one of the fastest growing pines known, and in addition has the heaviest, hardest and strongest wood of all the commercial conifers of the United States.

bia, Oregon, Colorado, Nebraska, Arizona and California, and seed is expected in the fall of 1928 from individual trees of this species growing in Washington, Idaho and Montana. As seed crops permit, the localities represented, and the number of trees in each locality will be materially increased.

Methods of Finding Superior Parent Trees

It would seem to be comparatively easy to go into a so-called even-aged stand of trees and by means of systematic measurements and age determinations by increment borings, find out accurately just which trees of the stand are the largest *for their age*—that is, which ones of a certain age have the greatest cubic volume, as determined by their height, diameter and form. It was found after field trial that this "Tree Selection" method was hardly feasible for the reason that an increment boring will not give the *exact* age, due to the difficulty in counting the rings near the center when the boring is taken at the ground line. When there is uncertainty in this matter it is very difficult to segregate out the fastest growing individuals by field measurements.

Another method is being tried in an effort to locate trees in the forest that have the inherent capacity for unusually fast growth. The plan is to base the selection, not upon measurements of the trees themselves, *but upon the relative growth of their progenies in the nursery*. This fundamental principle is widely used by successful breeders of both plants and animals. It should bring to light hereditary differences, as these are the only ones that are passed on to the offspring through the seed. The



FLOWERS OF THE WESTERN YELLOW PINE

Figure 4

At the left are staminate or male catkins, while at the right are the ovulate or female flowers. Both are somewhat enlarged. The resemblance of the ovulate flowers to the mature pine cones may be clearly seen. The ovules lie exposed at the base of the tiny scales that make up the flower.

progenies can be compared under the controlled uniform conditions of an experimental nursery; while the parent trees themselves can only be compared under the very diverse growing conditions in the forest where no two trees have exactly the same surroundings, and in which it is most difficult to tell how much is due to variations in environment and how much to inherent tendencies. Also, this "Progeny Test" method makes it possible to compare a number of representatives rather than single individuals, and thus strike averages of performance and growing conditions.

The light cone crops of 1926 and 1927 have so far restricted this method, but the present plan calls for collecting seed in the fall of 1928 from about 800 individual trees of Western Yellow Pine scattered as widely as possible throughout the range of this species. Two plots of each progeny, one-half foot by four feet will be planted in the nursery, and at the end of two years' growth, measurements and perhaps oven-dry weights of the seedlings will be taken to determine which 200 progenies out of the 800 have made the greatest development. Then seed of these 200, which was collected at the first collection, and stored in air-tight jars, will again be planted, allowing two or possibly three plots of each. At the end of another two years the number of progenies being saved will be reduced to the best 50. Then enough seed of each of these will be gathered to plant five plots of each progeny, as the experiment will by that time have reached the stage where it is practical to *prove* which two or three progenies are the best, by the use of quite a number of replications. This is hardly feasible in the early stages of the test, where nearly a thousand progenies are being compared.

Selection Among Nursery Seedlings

The methods last considered have dealt with ways of finding the most rapid growing individual *trees* in the forest. The present method is intended to bring to light the best individual *seedlings* in a nursery. Due to the willing cooperation on the part of a majority of the large reforestation nurseries of the country, it has been possible to make selections for vigor among tremendous numbers of trees. In many of the nurseries visited the largest seedlings were picked from among hundreds of thousands of seedlings of a species, and in some cases, the number ran into the millions. It would seem that the relative chances of finding superior individuals is much greater by this method than by the other methods that have been discussed, since any one year's work in selecting trees in the forest is likely to have to be limited to a consideration of hundreds, or at most, thousands of individuals.

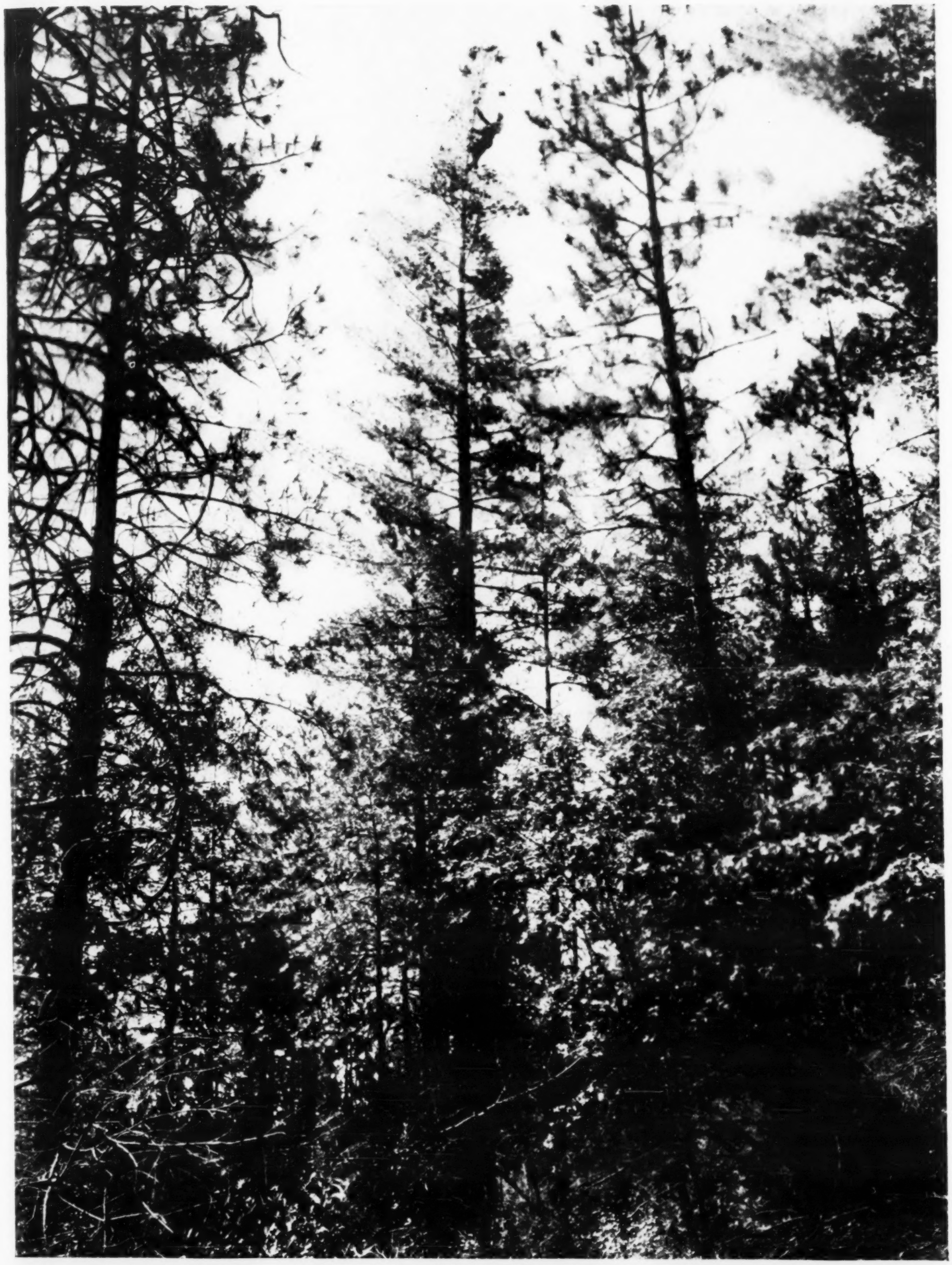
"Nursery selection" is, for the most part, carried on in seed beds where the seed has come from many trees and there is no record of parentage; hence it is essentially "mass selection." In a naturally *self-fertilized* species, the selection would be directed toward the segregation of the "population" into various pure lines, each having a different rate of growth, and each capable of reproducing itself true to type from seed if pollinated only by individuals of that line. But in naturally *cross-fertilized* plants, such as pines and walnuts, pure lines probably do not exist in the strict sense of the term, as the continual crossing does not allow for their development. In such plants, then, selections can, in the main, only be relied upon to locate individuals whose genetic constitution is heterozygous, but which, if raised to seed bearing age and self-pollinated, might be expected to yield a group of individuals which would exhibit some variation, yet would in general retain the vigor of the mother tree. However, when the selection is made among such large numbers there would also seem to be a fairly good

At the left are staminate or male catkins, while at the right are the ovulate or female flowers. Both are somewhat enlarged. The resemblance of the ovulate flowers to the mature pine cones may be clearly seen. The ovules lie exposed at the base of the tiny scales that make up the flower.

POLLINATION BAGS ON A YOUNG WESTERN YELLOW PINE

Figure 5

This rapid growing tree, on the Station grounds, is about 40 feet high and 14 inches in diameter breast high, and is only 19 years old. There were 94 pollination bags on it when the photograph was taken.



PRECARIOUS WORK IN BAGGING A TALL SUGAR PINE

Figure 6

This tree is growing in a dense stand, and ovulate or female flowers are to be found only at the top of the tree and at the extremities of the branches. The plant breeder who chooses the conifers as his field of work must add to his usual tools and abilities some of the attributes of the lumberjack and the lineman.

chance of discovering occasional vigorous mutations, which should come true from seed.

Pollination

It is interesting to note that among pines there are seven known natural species hybrids[1,2] and two species crosses that have been artificially produced, and that all but one are between pairs of species that are in the same relationship group.[3] The list follows:

Group Australes

P. palustris (Longleaf pine) × *P. taeda* (Loblolly Pine) = *P. sondereggeri*, H. H. Chapman, a natural hybrid occurring in Louisiana. See Figure 2.

Group Insignes × Group Australes

P. rigida (Pitch Pine) × *P. echinata* (Shortleaf Pine)—Reported by G. S. Perry as a natural hybrid growing at Mont Alto, Pennsylvania.

Group Insignes

P. murrayana (Lodgepole Pine) × *P. banksiana* (Jack Pine)—Reported by A. C. Holman as a natural hybrid occurring in Northern Alberta, Canada.

P. halepensis (Aleppo Pine) × *P. pinaster* (Cluster Pine) = *P. halepensi-pinaster* Saporta, a natural hybrid.

Group Lariciones

P. nigra (Austrian Pine) × *P. densiflora* (Japanese Red Pine)—Hybrid produced Dr. A. F. Blakeslee in 1914.

P. sylvestris (Scotch Pine) × *P. nigra* (Austrian Pine)—Hybrid produced by Clotzsch in Germany in 1845.

P. nigra (Austrian Pine) × *P. sylvestris* (Scotch Pine)=*P. neilreichiana* Reich., a natural hybrid.

P. montana (Swiss Mt. Pine) × *P. sylvestris* (Scotch Pine) = *P. rhaetica* Bruegg., a natural hybrid.

P. montana (Swiss Mt. Pine) × *P. nigra* (Austrian Pine) = *P. wettsteiniana* Fritsch., a natural hybrid.

The fact that there is only one known cross between *groups* of hard pines, would lead one to believe that such crosses are much more difficult to make than those between species of the same group. However, the small amount of pine pollination which was done in the spring of 1926 has yielded 24 seeds of the cross Western Yellow Pine × Swiss Mountain Pine (*P. montana*) and 29 seeds of the cross Western Yellow pine × Digger pine (*P. sabiniana*). Both of these are crosses of species in different groups, but groups which are fairly closely related. Several seeds of both of those hybrids have recently germinated.

Treetop Pollinations

Not the least of the pollination difficulties was the physical problem of reaching the female flowers to do the pollination work, as may be appreciated from a glance at Figures 5 and 6. It has often proved necessary to use climbing irons in ascending trees that are bare of limbs for many feet up, and linemen's safety belts have proved useful while working high up in the trees. The problem of how to reach the flowers at the extremities of long slender branches was solved by the use of a long heavy wire, having a hook at the end. By means of this simple device the limbs are pulled in and held in such a position that the flowers can be easily worked upon.

When the buds have developed to the stage where one can be fairly certain as to which will form new shoots and which will develop into ovulate (female) flowers, the latter type of buds are covered with bags to keep away wind-blown pollen. Wax paper bags, or heavy manila bags have been found very satisfactory under most conditions, but for work done early in the season when considerable rain and wind may be expected, paraffined cloth bags hold up better. After a period varying from one to three weeks, the ovulate flowers will completely emerge from the bud, and the tiny cone scales will be found spread far apart, exposing the minute ovules at their bases. At this receptive stage the bags are removed and the desired kind of pollen is dusted down into the numerous crevices of the flowers by means of a camel's hair brush, which has been dipped in a vial of the pollen. The bags are then replaced to avoid possible contamination

with foreign pollen. In about two weeks, after the tiny scales have closed in, the bags are removed.

In order to make certain that the pollen that is applied is the only pollen that has a chance to fertilize the ovules in the bagged flowers, a practice has been made of leaving unpollinated the flowers in every fifth bag. If these "check" flowers should develop into cones and produce fertile seeds, it would indicate that wind-blown pollen reached them, unless the flowers developed parthenogenically, which is unlikely. As none of the 1926 checks produced any seeds, it seems very probable that the technique in this respect is satisfactory.

Most of the samples of pollen used were tested for viability prior to their use in the field. Pine pollen was found to germinate best in a five to ten per cent sugar solution in a Van Tiegen Cell. Germination is usually complete in about 72 hours, at which time 75 to 90 per cent of the pollen grains will often have tubes which can be readily seen under the microscope. These tests have demonstrated the important fact that by keeping pine pollen in cotton-stoppered vials in the dark or in indirect light, it can often be kept alive and in good condition for several months, thus making possible many crosses which could not otherwise be attempted, due to the different blooming periods of pines in various regions. Trials of various methods of shipping pine pollen within the United States have indicated that a tight envelop is probably the best shipping container.

The majority of the pollination work in 1927 was done using Western Yellow Pine as the ovulate parent. The extent of this work can be appreciated by an inspection of Table I, which shows that pollen of 30 different species of pines was applied to the ovulate flowers of Western Yellow pine. It will be seen that the work was concentrated primarily upon trying to secure crosses of this species with others in the same relationship group, that is, Australes. Very fortunately this group contains the four important timber pines of the Southern states, namely, Slash (Figure 3) Loblolly, Longleaf, and Shortleaf pines, and pollen of all of these, secured from trees growing in various parts of the South, has been used. It will be noticed that Western Yellow pine flowers have also been pollinated with pollen of species belonging to six other groups of pines, and that the total number of flowers pollinated of this species was 7,648. Seven other species were used, to a smaller extent, as female parents, and two of them are included in the table. In addition to the pollen collected by members of the staff, there were received in the spring of 1927 shipments from 42 different people, which included 86 samples of pollen of 33 different species of pines. These shipments came from 23 states and from Canada, Mexico, Guatemala and the Philippine Islands.

As these pollination tests are being continued, the Station is desirous of securing pine pollen from anyone who would care to supply it to further the experiments. Seed of rare pines is also very much needed. In return for pine seed or pollen, the Station will be glad to supply seed of various California trees.

In work with pines, it is necessary to wait until the autumn of the year following that in which the pollination is done before the seeds can be collected, as all species of pines except the Mexican Yellow pine (*Pinus leiophylla*) and the Torrey pine (*P. torreyana*) require two seasons to mature their cones and seeds, these species requiring three seasons. A partial count of the set of the flowers pollinated during the spring of 1927 was made during January, 1928, and showed that cones had set of Western Yellow pine pollinated with pollen of the 15 species marked with an asterisk in Table I, including three of the four important Southern pines. Counts

TABLE I.—Number of flower Pollinated in Various Species Crosses of Pines

Male Parents			Female Parents		
			HARD PINES		SOFT PINE
Relationship Group	Scientific Name (PINUS)	Common Name (PINE)	P. ponderosa W. YELLOW PINE (Group Australes)	P. radiata MONTEREY PINE (Group Insignes)	P.lambertiana SUGAR PINE (Group Strobi)
HARD PINES	"Selfs"		•1070	•59	49
Australes	ponderosa	W. Yellow	•568		30
"	ponderosa scopulorum	Rocky Mt.W. Yel	•400		
"	caribaea	Slash	53	•64	
"	taeda	Loblolly	•328	•52	
"	palustris	Longleaf	•842	•89	22
"	echinata	Shortleaf	•511		4
"	montezumae	Rough Branched Mexican	• 94		
"	teocote	Twisted-leaved	53		
"	pseudostrobus	False Weymouth	8		
Insignes	radiata	Monterey	383	29	10
"	rigida	Pitch	167		
"	halepensis	Aleppo	244	9	
"	pinaster	Cluster	322		
"	banksiana	Jack	• 60		
"	muricata	Bishop	164		
"	murrayana	Lodgepole	•116		10
"	patula	Spreading-leaved	134		
"	virginiana	Scrub	•183		
"	attenuata	Knobcone	•2_5		
Macrocarpae	coulteri	Coulter	27		
"	torreyana	Torrey	184	32	21
"	sabiniana	Digger	•316		
Lariciones	insularis	Khasia			17
"	resinosa	Red	28		43
"	sylvestris	Scotch	•281		
"	nigra	Austrian	•249		10
"	nigra pallasiana		88		
"	thunbergi	Japanese Black	• 50		
Leiophyllae	leiophylla	Mexican Yellow	116		
Longifoliae	canariensis	Canary	238	25	26
Pineae	pinea	Italian Stone	• 76		
SOFT PINES Strobi	lambertiana	Sugar			68
"	strobus	White			20
TOTAL NUMBER OF FLOWERS POLLINATED			7,648	359	330

*Shows crosses which a partial count has shown to have set (count not yet made with sugar pines).

made on a few of the Monterey pine trees showed that cones had set of three species crosses, in addition to the selfs. A count has not yet been made on the set of the hand-pollinated Sugar pine flowers.

The crossing is being done with two principal objects in view; first, that of securing *hybrid vigor,* and second that of bringing together in a new hybrid form desirable qualities now occurring in two different species. An example of the latter would be a hybrid between Western Yellow pine and Slash pine (*P. caribaea*) to combine the great hardiness, adaptability and rapid diameter growth of the Western species with the rapid height growth strength of wood, and high quality naval stores* of the other. The ease with which any particular combination of characters may be obtained is proportional, to a certain extent, to the number of chromosomes possessed by the species in question. It is known[4] that pines usually have 12 pairs of these carriers of inheritance, although the number is sometimes 13 to 16. These numbers are about average for plants.

Inbreeding, which is also being tried, is known to be quite successful in fixing most characters for which selections are commonly made. There may be some doubt, however, as to its effectiveness in the case of the character "vigor," inasmuch as inbreeding has the reputation of gradually causing a loss in vigor. This, however, does *not* always occur, and the only way to find out the actual effect in a particular case is to try it, as is being done. Giant as well as dwarf strains have been developed by this means.

The writer would like to extend to all those who are interested in the work a cordial invitation to visit the experimental Station at Placerville and see the various tests that are under way in the nursery and arboretum. If a visit is not possible, the writer will appreciate hearing from those who are thinking along these lines, and he will welcome criticisms of statements or of methods being employed.

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*Turpentine, rosin, tar.

MAN IMPROBABLE

A Fundamentalist Evokes the God of Chance to Demolish Evolution

"MATHEMATICAL Probability is a branch or division of mathematics by means of which the odds in favor or against the occurrence of any event may be definitely computed, and the measure of the probability or improbability exactly determined. Its conclusions approximate certainty and reveal how wild the guesses of evolutionists are.

"The evolution of species violates the rule of mathematical probability. It is so improbable that one and only one species out of 3,000,000 should develop into man, that it certainly was not the case. All had the same start, many had similar environments. Yet witness the motly products of evolution: Man, ape, elephant, skunk, scorpion, lizard, lark, toad, lobster, louse, flea, amoeba, hookworm, and countless microscopic animals; also the palm, lily, melon, maize, mushroom, thistle, cactus, microscopic bacilli, etc. All developed from one germ, all in some way related. Mark well the difference in size between the elephant, louse, and microscopic hookworm, and the difference in intellect between man and the lobster!

"While all had the same start, only one species out of 3,0000,000 reached the physical and intellectual and moral status of man. Why only one? Why do we not find beings equal or similar to man, developed from the cunning fox, the faithful dog, the innocent sheep, or the hog, one of the most social of all animals? Or still more from the many species of the talented monkey family? Out of 3,000,000 chances, is it not likely that more than one species would attain the status of man?

* * * * *

"* * * The Revolutionary War, out of 3,000,000 people, developed one great military chieftain, but many more approximating his ability; one or more great statesmen with all gradations down to the mediocre; scholars and writers, with others little inferior; but there was no overtowering genius 10,000,000 or 10,000,000,000 times as great as any other. We would be astonished beyond measure, if any great genius should rise in any nation as far ahead of all others, as the species of mankind is ahead of all other species. It is unthinkable that one species and only one reached the measureless distance between the monkey and man. It violates mathematical probability.

"We have a right to expect, in many species and in large numbers, all gradations of animals between the monkey and man in size, intellect, and spirituality. Where are the anthropoids and their descendants alleged to have lived during the 2,000,000 years of man's evolution? They can not be found living or dead. They never existed. Creation alone explains the great gap. What signs have we that other species will ever approximate, equal or surpass man in attainments? Can we hope that, in the far distant future, a baboon will write an epic equal to Milton's Paradise Lost, or a bull-frog compose an oratorio surpassing Handel's Messiah?

* * * * *

"Evolution is not universally true in any sense of the term. Why are not fishes now changing into amphibians, amphibians into reptiles, reptiles into birds and mammals, and monkeys into man? If growth, development, evolution, were the rule, there would be no lower order of animals for all have had sufficient time to develop into the highest orders. Many have

remained the same; some have deteriorated.

* * * * *

"It is unreasonable to believe that one species and only one out of 3,000,000 by evolution should attain the status of mankind; and that one species and only one species of the primates should reach the heights of intelligence, reason, conscience and spirituality. Huxley says, 'There is an enormous gulf, a divergence practically infinite, between the lowest man and the highest beast.'

"To declare that our species alone crossed this measureless gulf, while our nearest relatives have not even made a fair start, is an affront to the intelligence of the thoughtful student. It does fierce violence to the doctrine of mathematical probability. It could not have happened."

—*The Evolution of Man Scientifically Disproved by* Rev. William A. Williams, D. D., Ex-President of Franklin College, Ohio., Published by the Author, 1202 Atlantic Avenue, Camden, New Jersey.

An edition of 20,000 copies is announced and testimonials are included to show that the work is being received in certain religious circles as completely disposing of the "delusion of man's descent from brute ancestry," "tearing to shreds evolution pretensions," and disproving "every claim of Darwinism." Some of the endorsements are from prominent sources in the religious world, and are significant of the state of information regarding biological facts and statistical methods among those who are still being misled by the notion that Christianity and evolution are in conflict.

A Revised Plant-Breeding Text

Breeding Crop Plants, *by* H. K. Hayes and R. J. Garber. Second Edition. Pp. 438. McGraw-Hill Book Company, New York, 1927.

IN this revised and enlarged edition of *Breeding Crop Plants*, Hayes and Garber have made available to students, teachers and investigators in the field of crop improvement, an excellent up-to-date summary of the facts regarding the mode of inheritance of many of the important characters of crop plants.

A new chapter on Biometrical Methods has been added. Much of the subject matter in the other chapters has been re-written. Considerable new material appears elsewhere in the book. Especially is this true of such subjects as breeding for disease resistance, chromosome numbers in relation to taxonomy of crop plants, species crosses and the genetics of maize.

Chapter headings are as follows: I. Introduction, II. Plant Genetics, III. Biometrical Methods, IV. Field Plot Technic, V. The Mode of Reproduction in Relation to Breeding, VI. Controlling Pollination, VII. Some Results of Selection with Self Fertilized Crops, VIII. Some results of Crossing as a Means of Improving Self-Fertilized Crops, IX. Methods of Breeding Small Grains, X. Classification and Inheritance in Wheat, XI. Classification and Inheritance of Small Grains other than Wheat (Oats, Barley, Rye, Buckwheat, Rice), XII. Cowpeas, Soybeans, Velvet Beans, XIII. Flax and Tobacco, XIV. Cotton and Sorghum, XV. Inheritance in Maize, XVI. Maize Breeding, XVII. Grasses, Clover and Alfalfa, XVIII. Potato Improvement, XIX. Breeding of Vegetables, XX. Fruit Breeding, XXI. Farmers' Methods of Producing Pure Seeds.

A glossary contains definitions of

about a hundred terms used in plant breeding and genetics.

The list of literature citations contains more than 850 titles, and will prove a very useful feature of the book, especially to graduate students and investigators. This book in its revised and enlarged form (438 pages, compared to 328 pages in the first edition) will provide ample lecture, discussion and reference material for a semester course in crop breeding, with three class periods a week.

The arrangement of the subjects is logical, except that Chapter IX on "Methods of Breeding Small Grains," should by all means precede Chapters VII and VII, which deal with particular methods, i. e., selection and crossing, respectively.

In general, the high standards set in the McGraw-Hill publications in the agricultural and botanical sciences have been maintained in this volume, although a number of minor typographical errors are to be noted. It seems strange and somewhat unfortunate that the authors, the consulting editor, and the publisher's proofreaders have allowed a good many minor slips in English usage to creep into book.

Throughout the book the authors use the word *quite* as it is commonly but incorrectly used in the United States. They would do well to follow the advice of H. W. Fowler* who says "'Quite right' is all right, and 'all right' is quite right, but 'quite all right' is all quite wrong."

Errors in subject matter, either of commission or omission, are rare, and the authors are to be complimented for having so carefully assembled so much technical information about so many crops and breeding problems.

It may appear that the reviewer has gone out of his way to point out minor defects in the book. It is not intended that the mention of these errors shall obscure the main purpose of this review, which is to recommend the book heartily to every teacher, investigator and serious student in the field of plant breeding. For seven years the reviewer has used *Breeding crop Plants* in his Crop Improvement classes at the Kansas State Agricultural College with much pleasure and profit. He congratulates the authors on the timely revision of their very useful text and expresses the hope that the book and the authors may continue to have their well deserved full measure of success.

J. H. P.

*A Dictionary of Modern English Usage (Oxford, 1927).

A CASE OF CLOSE AUTOSOMAL LINKAGE IN THE FOWL

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SINCE 1919, a systematic study of linkage relations in fowls has been carried on at the Genetical Station of Anikowo. About twenty genes have been studied, among them, rose comb, pea comb, Y-shaped comb, crest, muff, polydactyly, dominant and recessive leg-feathering, bare-neck, frizzling, short leg, some genes for coloring, etc. As the nature of characters gives no evidence concerning the location of genes in chromosomes, it was necessary to get all possible double combinations of genes of the type $\frac{AB}{ab}$ or $\frac{Ab}{aB}$ and to analyze them by means of mating such diheterozygous birds to the recessive analysors $\frac{ab.}{ab.}$ In the case of two genes A and B being located in one chromosome or in two homologous chromosomes—i. e., belonging to the same pair of chromosomes—they reveal linkage in the birds of the structure $\frac{AB}{ab}$ and a repulsion in the birds of the constitution $\frac{aB.}{Ab.}$

Out of 20 factors may be formed $\frac{20\times19}{2} = 190$ double combinations. All of these pairs have not as yet been investigated, but about 120 pairs provided material amounting to 12,000 observations. A detailed report of this work is to be published.

In the summer of 1927 we discovered the first case of close linkage between autosomal genes. The genes for *rose comb* (*Wn* = wene) and *short leg* (creeper) (*Rd* = rode) displayed a strong repulsion. Rose comb, one of the best known hereditary characters of fowls, may be identified in newly hatched chicks or even those dead in shell. Its segregation is very easily observed, the ratios obtained being very regular. For instance, in the *Wn.wn* × *wn.wn* matings, the *Wn.wn* chicks produced number 520 and the *wn.wn* 483. The short leg condition represents one of the most convenient dominant genes in fowls, as even with the chicks freshly hatched or dead in shell normal legs easily are distinguished from the short ones. The variation probably is the same at that which Crew (1925) mentioned in the Scots Dumpy fowl, and supposed by him to be lethal; and which Cutler (1925) and Dunn and Landauer (1926) have described in "creeper" fowls, where according to the last-named investigators it is due to a dominant gene, which is lethal when homozygous.† From this standpoint our *Rode* gene is not as yet studied. This lethal effect does not affect our experimental investigations of linkage relations, since no homozygotes occur, as our matings have followed the scheme:
Rd.rd × *rd.rd* —— *Rd.rd.* + *rd.rd.*,
the ratios obtained being regularly 1:1. In all we have obtained 109 *Rd.rd* and 92 *rd.rd.*

In 1926, a "creeper" cock (*Rode*) with single comb (*wwne*) was mated to a normal-legged hen (*arode*) with the rose comb (*Wene*). The resulting offspring was a rose-combed creeper cock No. 10.329. Accordingly its

*Translated by Miss Barbara Glessing, U. S. Department of Agriculture.
†Illustrations of "Creeper" fowls and of their reptile-like leg-bones were published in the Journal for October, 1925.

genetic formula is to be expressed thus: $\frac{Wn \ . \ rd}{wn \ . \ Rd}$

In 1927 this cock was mated with 8 normal-legged hens carrying the single comb: i. e., of the composition $\frac{wn.rd}{wn.rd}$ From this mating were obtained 60 chickens. In the case of independent inheritance, all the 4 phenotypes (*Wn.Rd; Wn.rd; wn.Rd*, and *wn.rd*) should have appeared in equal numbers: i. e. 15 ± 3.4 chicks of each phenotype. Actually the series proved to be as follows: 1 rose creeper: 22 rose normal: 33 single creeper: 4 single normal. Table I. Instead of free combining of both factors, nearly all the chicks with rose comb proved to have normal legs (22:1) and chicks with single comb were almost all creepers (33.4). Thus, the genes *Wn* and *Rd* reveal a strong repulsion broken only in 8 per cent of the cases.

We therefore have to conclude that these genes are located in a homologous pair of chromosomes and must be put on the map of one of the autosomes of fowls at the distance, approximately of 8 ± 3.5 morganids from each other. The *Wene* gene, as more common, is placed on the left and taken for 0.0 until the discovery of other genes in this group.

The discovery of this linkage between dominant genes which are very convenient for such experiments allows us to proceed to the detailed study of the phenomenon of crossing over in the autosomes of fowls, and to investigate the influence of the sex, age of the heterozygous parents, and other factors, on this phenomenon. It is important that experiments be made to determine the influence of this part of the chromosome on egg-laying, growth, and similar characters of economic value in fowls. As all such experiments will take up much time and strength, it is advisable that other experiment stations should include the study of the pair of genes *Wene* and *Rode* in their programme.

TABLE I.—Results of mating $\frac{Wn. rd}{wn. Rd}$ X $\frac{wn. rd}{wn. rd}$

Matings		Phenotype of Chicks			
		Wn. Rd Rose comb Creeper legs	Wn. rd Rose comb Normal legs	wn. Rd Single comb Creeper legs	wn. rd Single comb Normal legs
♂ 10329x	♀ 5260	0	2	5	1
	♀ 5323	0	0	4	0
	♀ 5349	0	1	2	0
	♀ 9450	0	2	1	0
	♀ 10442	0	3	6	0
	♀ 10499	0	4	1	0
	♀ 10540	0	1	2	0
	♀ 10791	0	3	4	2
	♀ ♀ xx	1	6	8	1
	Totals	1	22	33	4

NOTE—In the column ♀ ♀ xx are placed chicks whose mothers are not exactly known (since the eggs were found in the grass and the like).

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CRIME, HEREDITY AND ENVIRONMENT

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CRIME is a term applied to the more important infractions of the mores. What are these mores? They are the conventional rules of behavior; the manners that make the man. The mores are different in different countries, partly because peoples and their instincts are different. Everywhere, however, they have developed as a result of experience through the generations with the men and women of the particular country. They represent the body of rules that ought to be followed by all to secure the happiness of the greatest number. For, in any gregarious species actions must be determined, in part at least, by the *common* good. The carrying out of instincts must be modified by a consideration of other members of the species. The human mechanism, like that of other altruistic species, is ordinarily provided with a means of shunting off the operations of one's instincts for altruistic reasons. Hence, the possibility of outlining the mores of altruism with the expectation that they will be lived up to.

Criminality is the phenomenon shown by persons who occasionally, or more or less regularly, commit acts strongly condemned by the mores, such as putting at hazard the life and property of other individuals of the community or of showing themselves in other ways to be a danger to the common good. The criminalistic person may be one who commits a single crime under a strongly aroused impulse or he may be one who repeatedly, or habitually, commits crime.

Crime is always a *relative* thing, having relation to the mores or to the behavior that is expected of one. In one country bigamy is a crime; in another it is the conventional mode of life. In one country the taking of property from a stranger is a crime but in certain desert countries it is in accord with the mores. In some parts of our country the transporting of liquor is against the mores, but in other parts not; for the law and the mores are not always the same. Taking life is ordinarily considered one of the greatest of crimes, yet in time of war the mores of peace are replaced by others that applaud the killing of enemies of the country. From the biological standpoint the important element in criminal behavior is the failure of the individual to meet the requirements of the mores; and for the biologist the inquiry is,—why such failure? For most persons do habitually show themselves able to meet the mores. Persons who fail to meet them are the ones to be explained.

Heredity and Environment as Causes of Crime

Granting that there are persons who more or less habitually fail to abide by the mores, the question arises concerning the source and significance of this failure. There undoubtedly is no one source or significance of the failure any more than there is one kind of criminal. We are dealing not with simple phenomena to be explained. We are dealing with a broad field of action or rather of interaction between persons and their surrounding world, involving numerous stimul and varied response.

There are those who maintain that crime is altogether a matter of training. According to this theory the cure for crime is a more strenuous training of all persons. We can influence human behavior, according to Professor Overstreet, by awakening interest and offering incentives. From

this point of view a community's failure to keep down crime is due to its own shortcomings in education and in moral culture. The large amount of crime in the United States should cause us to hide our heads in shame at the neglect of our duties. Were we to put more money into schools and moral education and religious training we should reduce crime to practically nothing.

On the other side there have not been lacking those who have looked at crime as the result of the hereditary make-up of the criminal. For such, the criminal is born and not made. The Italian School, under the leadership of Lombroso years ago, taught, indeed, that criminals belong to a morphological race, apart from other people. They could be told by a number of stigmata of crime and degeneration. No doubt there are those who would believe that men are born who must, inevitably, commit heinous crimes unless enclosed within four walls or kept isolated on an ocean island.

Both of the preceding views meet with certain difficulties, arising from common experience. We have reason for believing that the Catholic priest was too sanguine, who said, in effect, "Give me the training of any child from two years of age and I can make him what I will." There are many institutions in the country who take children, even at the tender age of 2, 3, or 5 years, and bring them up with careful discipline, often surrounded by more than the comforts of the average home. The children are trained to associate and behave properly with their fellows under surroundings which must develop their altruistic instincts. Hundreds of orphans have been taken at an early age and reared in good families under the best of conditions. Tens of thousands of children, every year are born into good families and reared with intelligent and affectionate care at their native homes and in the schools. The result of all of these experiments does not warrant the conclusion that difference in training is the only reason why some children abide by, and the others constantly break, the mores. Even in the same family there are those who are normally and constantly well controlled and live an altruistic life, while a brother or sister shows from an early age criminalistic tendencies. Thus I have in mind a boy who does well at school, except for inattention. He prefers the companionship of older, wild boys; he lies, steals and runs away from home. He has two fine studious brothers. His father is a strong character and a successful lawyer; his mother, is an excellent woman, intelligent and firm. But her father's father was erratic and nomadic; and he preferred to go about in an Indian blanket. He traced back to Indian ancestry. He has three nomadic descendants.

Surely it can not be only lack of training which is responsible for criminal behavior. For orphan asylums, and special homes for training deserted children yield, alongside of a gratifying percentage of children who are well conducted in later life, an equally striking proportion of those who behave very badly.

The hypothesis that faulty heredity is alone responsible for bad behavior also fails of explaining satisfactorily the phenomena of crime. All nations have noted after the close of a long war that the frequency of criminal behavior rises sharply. This is not because a new generation of children, with peculiar criminalistic traits, is come upon the stage. Obviously, generations do not appear in this fashion. Also it has been shown that in a community characterized by a high crime rate there may be a sudden and marked decline in the crime rate whenever the community rises to the situation by handling crime in a prompt and thorough fashion. When the Vigilantes of San Francisco took hold of the crime situation and hanged con-

victed criminals at the nearest convenient lamp post there was a tremendous decrease in criminal behavior. This was not solely because all of the criminals had been hanged, nor because the rest of them had been driven out of the country but because the emotion of fear was exerting itself to control the behavior of those who lacked adequate, altruistic instincts. We must reach the conclusion, then, I think, that both hereditary peculiarities and environmental conditions play a rôle in determining criminal behavior.

I was speaking with a lawyer about this the other day and he remarked that the great problem to be settled was the relative importance of heredity and of evironment in human affairs. He seemed to think that mankind was without any definite, experimentally achieved, information on the subject; that it was something quite mysterious and would some day be made the subject of thoroughgoing investigation. It would seem very remarkable, if true, that mankind during the course of 300,000 years and more in which it has lived as a gregarious species, should never have got any light upon the question of the relative importance of heredity and environment in determining the traits or qualities of the individual. A moment's consideration shows that, indeed, mankind understands perfectly well and has understood perfectly well for thousands of years the real relation of these two elements in development. The group of mankind which has been especially interested in this problem and has worked out its solution, because of its importance to its wealth and social position, is that of the herder and the farmer. The farmer has no doubt about the relative importance of heredity and environment. In fact he never raises the question at all; he knows exactly how both are to be used. Thus, he first decides in the spring what kind of a crop he wants to secure, both in respect to quality and quantity. If he is to raise wheat for the flour mills, then he must get a particular strain of that species. If he is to raise it for macaroni then he must have a strain with a large percentage of gluten. If he is to raise corn for the table in the early summer then he gets a sweet variety like Golden Bantam. If he wants large stalks for the silo, then he seeks an eight foot variety. If he is to sell his corn for syrup then he seeks a larger sugar content. If it is to be used largely for oil, still another type has to be grown. But whatever type he selects the farmer knows that he must give the best possible culture in order to bring out the best possible development of the capacities of the particular variety that he has selected. And this culture will be very different according to the nature of the variety: very different the culture required by the dwarf Golden Bantam from the culture demanded by the Boone County White; a wholly different treatment of the soil to cultivate watermelons and huckleberries. For what is necessary to the one is fatal to the other.

There is no such thing as a universally good heredity. No heredity is the best *per se*. There is no universally good training; no course of training is best *per se*... The quality of any inheritance is good only in relation to the work its possessor is called upon to do. Similarly, a training is good that is adapted to bringing to full development the particular, useful hereditary peculiarities that the individual may posses. What is good inheritance for one person may be poor inheritance for another. A clear, blond skin may be a prized inheritance in the north but it puts one at a disadvantage if one has to live in the tropics. What is good culture for one person with one set of traits may be poor for another with a different set of traits. I know of a factory where useful rugs are woven. The persons

who make them have received a good education; yet they can not read or spell and many of them can not talk, though they can hear very well. They are low grade imbeciles. Their education is a good education, for them, because it is adjusted to drawing out just the capacities that they have.

To return to our subject of criminality. The criminal is, in general, the product of inadequate social instincts, of feeble self control, of a training which, however good for the average person, is very poor for the special type. The output would not be changed were there to be more training of the generalized type, because this training is not adapted to the traits to be developed. The average culture will fail of bringing out altruistic behavior from a person who has a deficiency of altruistic traits to cultivate, just as the most assidious cultivation of the Bantam corn will not make an eight foot stalk.

Types of Criminals

Let us consider, then, something of the traits which are found in persons who commit crimes of different types and let us see what sort of culture should be applied to them. I must say, at the outset, that there is a great number of types of crime and I can not weary the reader by attempting in a brief space to go into details concerning all of them. I have for some time been especially interested in the group of wayward girls, as found in State institutions, and will start with this group in a discussion of the elements of criminal behavior.

The girls found in such institutions are characterized, on the average, although by no means uniformly, by certain peculiarities of behavior which differentiate them from the most of the population. Above all, they show extraordinary, more or less periodic, outbreaks of bad behavior. In the interval between such outbreaks their behavior may be fairly satisfactory. They often show more or less constantly an absence of properly developed social instincts. The characteristic feature of their behavior is that it is concerned primarily with themselves; their own inclinations and desires. As a group they are inordinately vain. They are especially fond of dress and finery, such as would attract attention to themselves. They commonly lack sensitiveness so that they perform cruel acts on animals and children which would be unthinkable in the average girl, such as putting the family cat on a red hot stove. They are characterized often by pathological lying; by elaborate stories of happenings which have no basis of truth but which often express a childlike wish-fulfillment; stories which tell of the attention they have received, of the attractions that they have exerted upon others and the like. Among them are many who are pyromaniacs, kleptomaniacs and nymphomaniacs and show other more or less periodic outbreaks which may be associated in some cases with migraine and epilepsy. The behavior which society finds worst in them and for which they are ordinarily incarcerated is lack of control in the sex sphere. They are erotic, even while still children, and early plunge into the grossest sex immoralities. They may have a good mentality and may have been taught how they should behave. But they have no means for shunting off their instincts.

It can be shown that some of the periodic behavior is associated with a periodic loss of control such that the person may steal while in a hazy state, without great insight into what she is doing and certainly without ability to interrupt or turn aside that action. Some of these girls are subject, at particular times, to tremendous outburst of temper during which they assult, even threaten killing, although they rarely carry out these threats. At other times their disposition may be quite placid.

The question now arises how much of this bad behavior can be explained by the concurrence of an insufficient heredity and inadequate training. It seems to me if can nearly all be explained by the combination of the two. These criminalistic persons are such by virtue of peculiar traits, or at least a behavior output which is highly abnormal. For them the ordinary school and home training does not result in the control of their tendency to outbreaks. They are feebly inhibited, and the instruction of home and the lessons of the school do not strengthen their inhibitions. For such, the weak inhibitions can not be controlled by reason. Such strength can be supplied only through the emotions and, specially, through fighting one strong emotion by another. In some cases the emotion of fear may serve to strengthen the weak self-control; in other cases the emotion of religious devotion—the devotion to an ideal. In some cases ambition may be aroused to a point where it will serve as substitute for a normal self control. In other cases a physiological means may serve, such as the therapeutic effects of vigorous physical activity. We may believe that in the near future it will be possible to weaken the outbreaks through endocrine therapy or through surgical operations. The point that I would like to stress is that just miscellaneous training will do nothing for such persons; but only a culture which is adapted to their particular needs.

We may now pass to another type of crime. Let us say that of burglary. A typical burglar is a young man, often a boy, whose career is frequently made in the company of other boys—bad companions. These understand him for what he is, a person who is suggestible, easily led, lacking strong social instincts, looking inward rather than outward, often of a mental type cut off from social contact. His vanity is great and may be acted upon to a point where he is willing to undertake a risk to satisfy his love of praise from the gang. If success crowns his early efforts he may continue independently along the line that has proven so successful. What training has been lacking in his case which should be restored to prevent his becoming a criminal? Probably the worst training for such a boy would be that which the ordinary schools afford—training of the purely intellectual processes. For in school, development of the individual's personal mind and acquisition of knowledge are stressed and little regard is had for fellow students, except as steps in the ladder of his own progress. What the introvert boy, like every schizophrenic or unsocial creature, needs is more contact with the real world, such as he would get in the farm, in the carpenter shop, in the machine shop. It is probable that his introvert tendencies might thus be broken up at an early age. Thus he would be put in a position where he might more readily respond to a training which stressed the importance of regarding the welfare of other people; even though, through lack of innate, social capacities, he may never become a frank, generous-hearted, self-sacrificing individual.

Prompt and Painful Punishment

I have used two illustrations of specific types of criminals to illustrate something of the complexity of the whole problem of the criminal and to indicate how behavior depends upon the constitution of the individual criminal. I have attempted to show, also, how training in order to be effective must take cognizance of the special make-up of the individual. These special studies may seem not well adapted to throwing light upon the question which is uppermost in the minds of the people during a wave of crime. The question: How can we stop it? Is there any single panacea for crime; that is, for all of the different kinds of crimes which are being

committed? Obviously there is not: but it is doubtless true that we can reduce crime by taking advantage of the principle that the criminals are, one the whole, a feebly inhibited lot and also a selfish, introvert lot. These may be considered central traits of the criminal group, though I would insist again upon the great variety of traits that are found in this group. In times, then, of wide spread crime it is necessary to fight weakness of self control by awakening vigorous emotions which shall strengthen the weak self control. The emotion of fear is one of the most effective of these and especially the fear of pain. This is nature's own method, indeed, of securing action in accordance with her laws. If I jump off a high building I am punished by severe pain, instantly I land on the ground. The relation of cause and effect is so clear that I do not repeat the experiment, no matter how weak may be my self control, or how strong my love of experiencing novelties or of attempting flight in the air without an adequate machine. So with the average criminal, if his act brings immediate punishment—immediate *pain*—he comes to associate almost instinctively the act with the pain and refrains from committing the act to avoid the pain. Unfortunately, inasmuch as the treatment of criminals is largely in the hands of a mercenary group of lawyers, who know no psychology, everything is done to dissociate in time the crime with the punishment, and the punishment, when given, is largely futile. Prompt and painful punishment is the best panacea for crime. Cutting out physical pain from punishment is the invention of the sentimentalist; not of the student of physiology and of Nature's laws.

With the group of schizophrenics who commit crime something may be done if they are taken out of school or society early and trained as artisans in work which takes them away from their introspection. There has been some success achieved by putting wayward boys into farming communities or even institutions where they are taught in the shops and with military drill. As for the periodic offenders their case seems to be the more pathetic and the least subject to environmental control. We have not yet discovered a physiological means of breaking up the periodic impulses. Isolation, during the period of strong impulses, will tend to reduce crime, but such isolation is not always feasible. Many such periodics should, undoubtedly, receive special care throughout their early life to protect them from themselves and others. Our great institutions for epileptics, (a group to which many periodics belong) seem, at the present moment, among the most hopeless of our institutions. The inmates are largely the products of very bad heredity or have undergone profound pathological changes in the brain. It is to be hoped that the nature of the combinations that have been responsible for the production of such persons shall become better studied and the results of such studies made known.

If a general, immediately available, prescription to aid in combatting the crime wave is desired it would be this. First, prompt punishment for the crime, regardless of the individual's make-up. Secondly, a study of the individual to find out the particular trait of his character that has made the particular criminal act possible, in order to see whether anything can be done to correct that condition. To my mind it is not always necessary to study first the criminal and then to adjust the punishment to the nature of the criminal. To my mind it is dangerous to decide that because a man is insane when he committed murder, therefore, he must not suffer the death penalty. If I may tell an allegory it would be that of the old woman who had a cat that acquired, after parturition, an insanity that led her to destroy her own kittens

and even attack other cats. The lady was preparing to drown this cat in a pail of water when a neighbor came in to whom she explained the situation. The neighbor exclaimed; "No, you must not do that because your cat is crazy. You must shut it up in a cage and feed it there for the rest of its life." Such a conclusion may seem ridiculous, when applied to cats. But it is conclusion we reach in the case of man. Apart from the death penalty, any punishment which is prompt and not unnecessarily severe, is generally useful, both for the feebly inhibited by substituting other emotion for his feeble inhibitions and in the schizophrenics by bringing his introvert nature in contact with a pain associated with external acts; by bringing home to him the fact that he is a member of a community that demands, under penalty of pain, that his actions shall take into consideration other people.

In conclusion I may urge that the widespread existence of crime enforces the lessons of eugenics. We are breeding too many people with feeble inhibitions and without proper *social* instincts; persons who have a tendency toward periodic outbreaks of temper and to assults; persons who are liable to periodic bad behavior, including the kind that is associated with the epileptic state; persons who are introverts, selfish and non-social. Satisfactory progress will be made only when we understand how those with congenital criminalistic make-up are bred and try to prevent such breeding. If we permit them to be born, then we must apply such special treatment as will prevent their behavior from disorganizing society.

The Population Conference at Geneva

ANOTHER conference! But something new this time even among the epidemic of post-war gatherings, for scientists from the principal countries of the world gathered together to consider the future of a world which some think is filling up with alarming rapidity and with too large a proportion of inferior products.

The conference did not consider only the actuality or possibility of serious over-population of the world but began with the simple known facts of the irregular distribution of people such as that England. Japan, etc., have concentrated populations whilst Canada, etc., have large uninhabited areas. Numbers showing the inhabitants per square mile are misleading as their value for happiness or misery depends upon the productivity of the soil and the means of access to food from other places. Even one man per square mile in a desert would die. Fifty years ago England could easily get all the wheat she wanted from the sparcely populated United States but if their present rate of increase continues they will soon be unable to send us any wheat.

All the world now belongs to some one nation and the question, often one of great international bitterness and difficulty arises, as to whether human beings who are too numerous in any country have an inalienable right to go and take possession of lands or labour in another country—should Europeans and Japanese have complete freedom to go, in whatever numbers they choose, into the United States; have unemployed Swiss and German waiters an undoubted right to come into England; the agricultural Pole into Germany; Italian workmen of all kinds into France? This conference hoped to be the means of creating a council of scientists, who, after adequate enquiry, will be able to settle in an amicable spirit the right of each

country to retain a certain standard of efficiency, culture and morals all of which might be seriously affected by unwise immigration.

The scientist-biologist, statistician-economist has produced by his experiments on animals and plants and by his studies of the past and present numbers of men, a magic instrument of some precision by means of which he can look into the future. If man continues to increase at his present rate all the fertile land in the temperate zone will be used in the next 30 or 40 years; there remains the tropics and the arctic regions, but even if the white man can persuade the native to produce efficiently, these areas can only keep us going a little longer. It has been stated that enormous numbers of reindeer, can be grown in Alaska. Hunger might easily drive us to that, more hunger would lower the standard of living till we would welcome the easily grown and nourishing soya beans and a further degree of crowding and hunger would make us turn joyfully to potatoes and the smell of a herring.

There are people who believe there is no need for alarm about man increasing beyond his food supply and they point optimistically to mountains, marsh and desert. Man may learn to grow corn in the Sahara and cabbages on mountain tops but one cannot help hoping that the wild places of the earth may never be all tamed for man does not live by bread alone. Many of the irrigated lands of which we are so proud are not as satisfactory as expected, for the excess of salts in the soil in time kills trees and grass. In both Colorado and Alberta much money has been spent with only temporary good results. Even in such crowded countries as England and Holland the towns are separated by great tracts of country but it takes at least 2½ acres to grow agricultural products for each human being.

Man can do many clever things but he will probably always be unable to create something out of nothing. We cannot escape from the fact that he is a prisonner in this world just as much as a gold fish is a prisoner in a bowl. When man has exhausted what is in the world he will certainly die unless he can stretch out his hands and make use of the universe. But, by scientific organization he will be able to keep a restricted number of people happy in the world as long as it exists.

Minerals are being used up. Iron is dug and rapidly turns into rust and when man has finished all the iron it seems as if it should be quite clear that the iron will be finished. It is generally agreed that you cannot have your cake and eat it and it may be wise for us to face the larger fact that you cannot use metals and coal and the products of the soil and still have them.

The productivity of the soil is less than it was; it has been suggested that such labouriously over cropped soils as that of Germany have become so deficient in phosphates and calcium that the food they produce also has too small an amount of these essential salts and so the human being in his turn suffers from an inadequate amount. A certain proportion of the products taken from the soil returns to it in the form of manure but we burn too much and the rain washes away too much for the give and take to produce equilibrium. The mines from which artificial manures are produced are some of the world's most precious possessions but they cannot endure forever any more than coal or iron.

A manufacturing country like England has been able to keep a large population with a fair standard of living because she manufactured goods for countries which were predominantly agricultural but as those countries (Argentina, Canada, United States, Egypt), make their own manufactured articles, the market of England must go and she and similar countries will

be left with a great population which has not a large enough area to grow its own food and warehouses full of goods which nobody wants to buy.

As the elements, iron, carbon, phosphate, etc., are changed but not destroyed, a wiser generation may learn how to collect rust and extract iron from it and to rescue from the sea the vast wastage of animal and plant life that passes away by rivers into the great waters. But for such a reconstruction of the earth, capable, industrious and wise men will be needed in large numbers and there are those who believe that we are not producing such in adequate amounts on account of the differential birth-rate. There is a wide tendency in Europe and America for the intellectuals and skilled workmen, our two most valuable classes, to produce small families whilst the irresponsibles have big families. That a differential birth-rate exists there is now no doubt but about its actual numerical value and its racial significance there is considerable diversity of opinion which will only cease when we have collected many facts. It would apparently be wiser to produce beings capable of a long, happy, productive life, in which there was little illness and death was long delayed; illness not only means misery for the individual but is a hindrance to the community for during illness the patient becomes a parasite on any kind hearted society.

The time has surely come for man to face the facts when he can collect them and although that is a long and arduous process it is not impossible. Then he can decide what he wants of life, what are his hopes and plans for an optimum population for each country and for the world; man is now too old to indulge in a *laissez-faire, laissez-aller* policy, accurate, wisely directed knowledge might take the world in hand and order it for the happiness of man. If civilization is worth anything it will be able to do just that and with such an end in view, people of diverse minds and beliefs organized and carried out this conference.

It is hoped that a permanent Population Council will be formed consisting of trained men, who, unattached to and unaffected by the protean changes of politics, will be able, in a spirit of international sympathy and without fear or favour, to put together information on migration, birthrate, deathrate, food supply, racial qualities and other questions. Such information, would, in time, enable future generations to order the world as a unit for the good of all.

O. A. Merritt-Hawkes.

A SEEDLESS GRAPE HARDY IN NEW YORK

Figure 7

The new hardy seedless grape, Station seedling number 10918, in the spring of 1927 which was the second year of its fruiting. In this year 13 clusters of fruit were produced, the largest of which is shown in Figure 8. The plant stands in a vineyard at the N. Y. Agricultural Experiment Station at Geneva, N. Y. The hybrid was produced in the first generation of a cross between a near-seedless Triumph×Dutchess seedling and the seedless *vinifera* variety, Sultanina rosea. The plant resembles its seed parent in hardiness, but in the character of its fruit it strongly resembles its *vinifera* pollen parent.

A NEW HARDY SEEDLESS GRAPE

A. B. Stout
The New York Botanical Garden

THE vine and the fruit of a new hardy seedless grape are shown in the accompanying Figures 7 and 8. This plant was produced in a project of breeding in which the writer representing The New York Botanical Garden is cooperating with the New York Agricultural Experiment Station.* The specific aim of this project is to produce seedless grapes of merit that are fully hardy in a climate such as exists in New York State.

This particular seedling (Station seedling No. 10918) possesses considerable merit and gives promise of value for general culture. It has thus far been hardy at Geneva, N. Y. It is vigorous in growth. In its second year of fruiting (in 1927) it bore thirteen clusters of fruit. The bunches are well filled and strongly shouldered and the largest (See Figure 8) was 8 inches long and 5 inches in the line of greatest width, and its weight was 15¾ ounces. This plant thus gives promise of being prolific. The berries are oval in shape, greenish white or pale yellow when overripe, sweet and vinous in flavor, and of good size for a seedless grape. In character and quality, the fruit closely resembles that of the well-known Sultanina (Thompson Seedless) now extensively grown in California both as a raisin grape and as a table grape. Its pollen parent is, however, the Sultanina rosea whose fruits often show a rosy color, but a rosy tint has not yet been observed for the new variety.

The Plan of the Breeding Work

The plan of breeding to produce seedless grapes grew out of a survey of the types of flowers in grapes with special reference to the kind of fruit produced. For this survey there were available many named varieties of grapes and several thousand seedlings being grown at the New York Agricultural Experiment Station. These studies† clearly showed that while the flowers of grapes may be classed as (1) staminate, (2) perfect hermaphrodite, and (3) imperfect hermaphrodite there are actually no distinct lines between these classes but instead there are many intergradations.

Special attention was directed to the flowers of seedless grapes. In these the pistils are capable of developing into fruits but the ovules do not function to the stage of yielding mature seeds. Their seedlessness may quite properly be called a weak grade of femaleness. But plants that bear seedless grapes are as a rule strongly male and hence they may be used as pollen parents in breeding.

Between the entirely seedless and the strongly seeded types of grapes there are plants which bear fruit that is "near-seedless." For example there are certain named clonal varieties that have only a few seeds per berry, or some of the berries may be seedless even when there has been complete pollination. Several seedlings were

*The writer is pleased to acknowledge the cordial and very helpful cooperation which has been afforded by the authorities and the members of the New York Agricultural Experiment Station and especially by Dr. U. P. Hedrick, Vice-Director of the Station, Mr. Richard Wellington, Mr. Olaf Einset, and Mr. L. M. Van Alstyne of the Department of Horticulture. Deep appreciation is also to be extended to the authorities of The New York Botanical Garden for sympathetic interest and for support of this project in breeding to develop seedless grapes.

†Types of flowers and intersexes in grapes with reference to fruit development. By A. B. Stout. Technical Bull. No. 82. New York Agric. Exp. Station. 1921.

FRUIT OF THE SEEDLESS HYBRID

Figure 8

Natural size photograph of the best cluster of fruit produced in 1927 by the new seedless grape (No. 10918). In the size of the clusters and in the size and character of the berries the fruit is quite similar to that of the well known Sultanina, the tender *vinifera* grape widely cultivated in California. The pollen parent of this vine was Sultanina rosea so named because its berries often have a rosy tint not possessed by Sultanina and thus far not observed in fruits of the new seedless vine. Natural size, but lower part of cluster not shown.

found in the vineyards of the N. Y. Agricultural Experiment Station that are to be classed as near-seedless. Many of their berries are without seeds, some have one seed each, and rarely two or even three seeds may be present in a berry. Such near-seedless plants may be used as seed-parents in breeding.

Horticulturists and grape growers in New York State have for some time had in mind the desirability of having hardy seedless grapes. Such plants have appeared and some of them have attracted attention as early as fifteen years ago. One of these is known as the "Hubbard Seedless," but this has not proved of value in culture.

Another hardy grape that has attracted attention is the "Concord Seedless" which was found growing with vines of the well-known Concord variety at Rushville, N. Y., some time previous to 1913. But this plant is not entirely seedless. From its seed four seedlings were grown to maturity at the N. Y. Agricultural Experiment Station and all of these bear fruits which contain only soft rudiments of seeds. The fruits of these particular seedless and near-seedless plants are of fair or even good quality but the bunches are rather too small for the plants to be considered worthy of general culture.

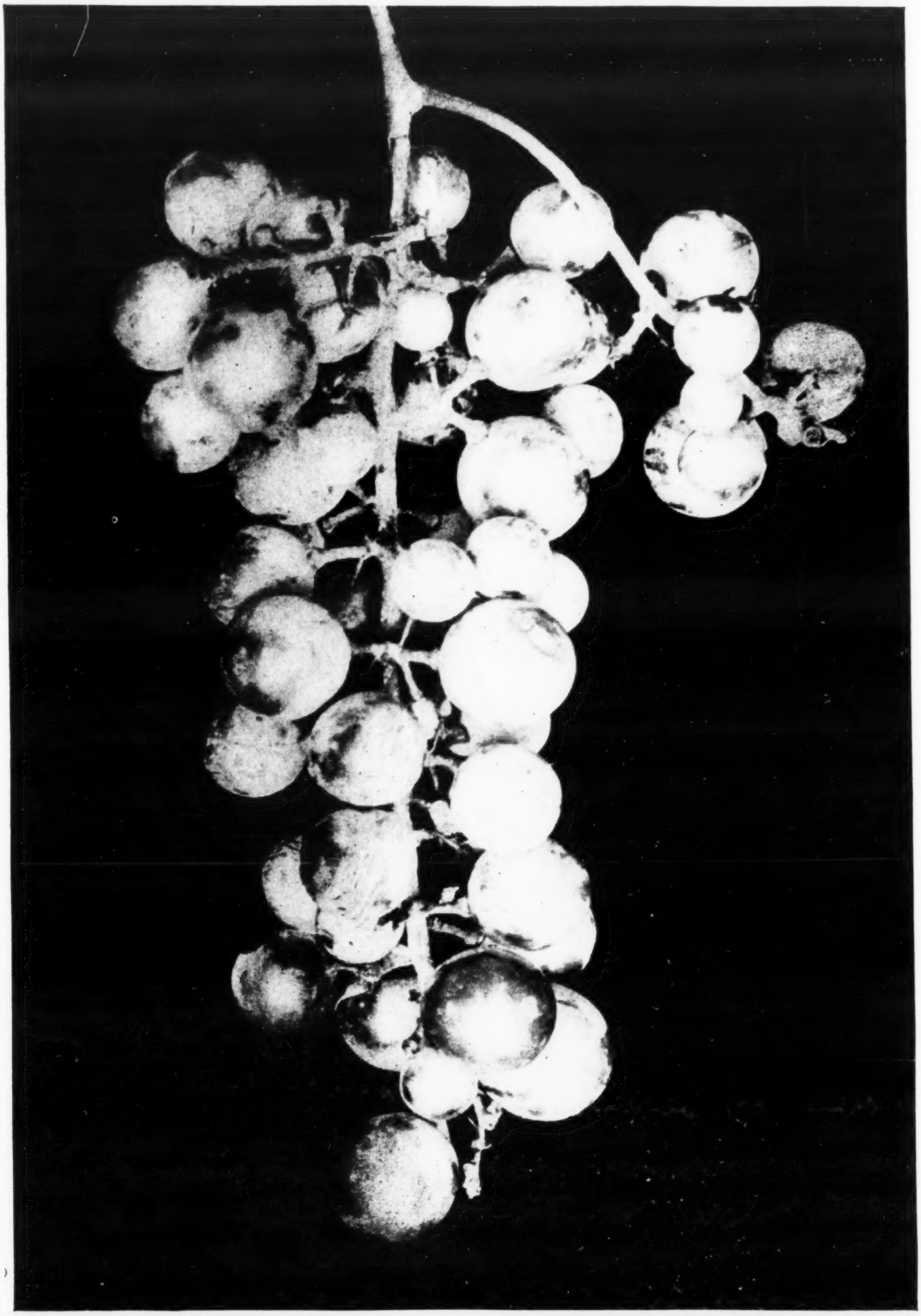
In the course of breeding work at the N. Y. Agricultural Experiment Station the Hubbard Seedless, the Concord Seedless, and the seedless seedlings of the latter have been used as pollen parents in crossings with various *seeded* commercial varieties. The F_1 progenies obtained were all seeded. The F_2 of several crosses have been grown. Various of the F_1 have been crossed to bring both the Hubbard Seedless and the Concord Seedless as grandparents into one progeny. But thus far these crosses of *seeded* with *seedless* and *near-seedless* have given only plants with seeded fruit. It would seem that in such progenies the segregation of at least some plants bearing seedless fruits may be expected on the general theory that multiple complementary factors are concerned in the heredity of seedlessness. Possibly such segregations require the growing of progenies in great numbers. From the view point of practical plant breeding one may say that in these crosses the weak grade of femaleness in the particular seedless and near-seedless plants seems to be strongly or perhaps fully dominated or swamped by the strong femaleness of the seeded varieties.

However crosses of *seeded* × *seedless* and *near-seedless* plants are being continued and also extended to include as pollen parents such valuable seedless varieties as Black Monukka, Sultanina, Sultanina rosea, Panariti, and Black Corinth in the hope that at least some of the combinations may yield some offspring that are seedless.

The main plan of breeding to produce seedless grapes was to make *near-seedless* × *seedless* crosses, and this method gave the new seedless plant (No. 10918) *in the* F_1 *generation*. The plan for this particular project in breeding was formulated at the beginning of the work in the following statement (on pages 14 and 15 of the Technical Bulletin No. 82 already cited):

> The most effective course in breeding for the development of seedless sorts is suggested by the conditions of intersexualism. Most individuals and varieties producing seedless or near-seedless fruits are strongly staminate. The former can be used as male parents on the latter which do produce a few viable seeds. Plants strongly male and seedless can be crossed with plants strongly male but weakly female and near-seedless and, also, the self-fertilized progeny of the latter may be obtained. In this way families weak in femaleness may undoubtedly be obtained in which a considerable number of individuals will produce seedless fruits.

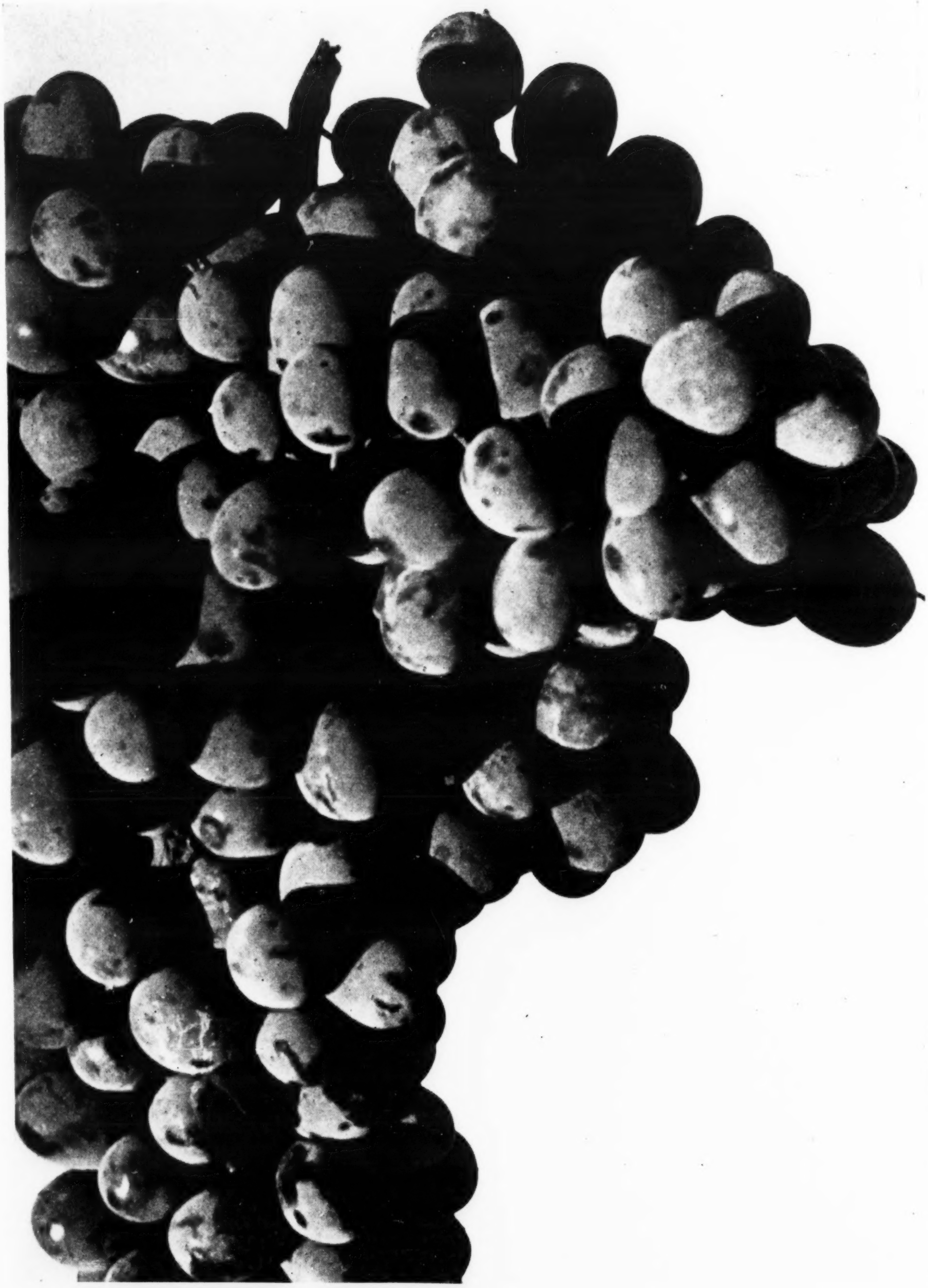
Some difficulty has been experienced in obtaining pollen of the *vinifera* seedless grapes, such as Sultanina and Sultanina rosea, for use in the breeding work. At Geneva these *vinifera* varieties are not hardy. They may survive



FRUIT OF SEED PARENT

Figure 9

A typical cluster of fruit from the seed parent of the new seedless grape. These fruits are of the slip-skin type, are white, sweet, and of good quality. The bunches are rather small and the vine is hence not very productive. But the vine is hardy and is near-seedless. Natural size.



FRUIT OF SULTANINA ROSEA—THE POLLEN PARENT

Figure 10

A photograph of a portion of a cluster of fruit of Sultanina rosea from a plant grown at Oakville, California and supplied by the courtesy of Mr. Geo. F. Husmann. This tender *vinifera* variety is the pollen parent of the new seedless vine to which it has imparted its high quanty of fruit and large size of the clusters. Natural size.

when laid down and covered with earth during winter. But even then they bloom sparsely and the pollen is shed latest in the season of bloom. Pollen has been shipped from The University Farm at Davis, California through the kindness of Mr. L. O. Bonnet and of Mr. A. J. Winkler. But such pollen was at best only feebly viable when it arrived. Vines of the various seedless *vinifera* grapes are now being grown at The New York Botanical Garden in court areas between greenhouses. These plants are thriving and some have bloomed rather freely and in time for use in cross-breeding both at The New York Botanical Garden and at Geneva. During 1927 a total of nearly 1,000 seeds were obtained to crosses in which pollens of Sultanina, Sultanina rosea, Panariti, Black Corinth, and the new seedless (10918) were used on near-seedless plants. Over 200 seedlings from previous crosses involving *vinifera* seedless varieties as pollen parents are now being grown in the nurseries. Possibly some of these will be seedless and possess merit.

The general plan of crossing *near-seedless* × *seedless* will continue to be followed as the main effort in breeding to develop new hardy seedless grapes. The new seedless plant is being used as a pollen parent. The near-seedless sport branch of its companion seedling will be propagated and used as a seed parent in further breeding.

The Parents of the New Seedless Plant

The seed parent of the new seedless plant (No. 10918) is a seedling (Station No. 9135) reared at the Experiment Station and is derived from the cross *Triumph* × *Dutchess*. It is hardy at Geneva. Its fruits are white or slightly pale yellow, sweet, and of the "slip-skin" type. Some of its berries are seedless but occasionally one or two seeds are presently in a berry. The clusters are rather small (See cluster in Figure 9), but are usually well filled. The vine seemed to be one of the best of the near-seedless plants available for the work of breeding at Geneva.

Sultanina rosea, the pollen parent used in this particular cross, is one of the "plant immigrants" of the U. S. Department of Agriculture and Dr. David Fairchild was personally concerned in its introduction. In a recent letter to the writer Dr. Fairchild recounts how this plant was found. This statement which may well be placed in record here, is as follows:—

> In 1899 while travelling with Mr. Barbour Lathrop he took me to Venice where I almost despaired of finding any plants worth introducing into America. I visited however the monastery of San Lazare on the Lido and met there Padre Issaverdens, the Father Superior. When I told him that I was a friend of William Dean Howells and had come to see if there were any interesting new fruits in Venice he received me with open arms. He had figured in Howells' *Venetian Life* and was a great favorite of the Howells family. He told me of a seedless grape which was growing in the monastery of Saonara near Padua and gave me a note of introduction to the Father there. I posted off to Padua and presented the letter and was referred by the Father to a small local nursery owned by the Fratelli Sgaravatti. Growing over the doorway to a small office building in the nursery I was shown a vine of this seedless grape. The clusters were not quite ripe and somewhat disappointing but undoubtedly seedless and of a decided pink color. I secured cuttings (S. P. I. 3921) and later I imported grafted plants (S. P. I. 5616). The story I was told is that a certain wealthy Roman by the name of Signor Santonetti who was at one time the major ducmo of the Pope presented a friend in Saonara about 1889 with some cuttings taken from a vine growing in the gardens of the Vatican. I have always felt it might be of Smyrna origin.

At the present time Sultanina rosea is not as well known as Sultanina which has preceeded it in cultivation in California. In speaking of the two the following statement is made in a letter from Mr. Geo. C. Husmann, Associate Pomologist, Grape Investigations, U. S. Department of Agriculture:

> The tremendous productiveness and the superior quality of the seedless raisins produced from Sultanina (erroneously called

Thompson Seedless in this country) has made it the most extensively grown grape in the United States. The Sultanina rosea resembles Sultanina in every way with this difference that on soils where it colors well it is of a handsome rose color. It is fully as productive and makes even a better quality raisin than Sultanina. This and because it is a delicious, early, seedless eating grape and the fruit lending itself to so many other purposes, should make it popular as a table, raisin, and general utility grape. It has many remarkable possibilities.

Cross-pollinations between the near-seedless seedling No. 9135 and Sultanina rosea were made in 1921. Thirty seeds were obtained. Sixteen of these germinated but all but two of the seedlings died in the nursery during the first winter. Evidently most of the seedlings inherited tenderness from the pollen parent.

Of the two plants that lived one is the plant already described as the new seedless variety. It has the hardiness of the seed parent and in respect to character and quality of fruit and size of the bunches it is strongly like the pollent parent—a combination of characters greatly to be desired. The other plant of this cross (Station No. 10919) is so unusual in behavior that it deserves mention. In its first year of blooming (1926) several of its branches bore flowers that were staminate and hence there were no fruits. But in 1927 a single branch which arose from the main stem at a distance of about eighteen inches above the ground bore several clusters of fruit while the rest of the plant was without fruit. These fruits were white and of good size and quality. One berry contained two seeds; all others had but one seed each. Thus, from a plant that appeared to be purely staminate, a branch arose which bears fruit and some seeds.

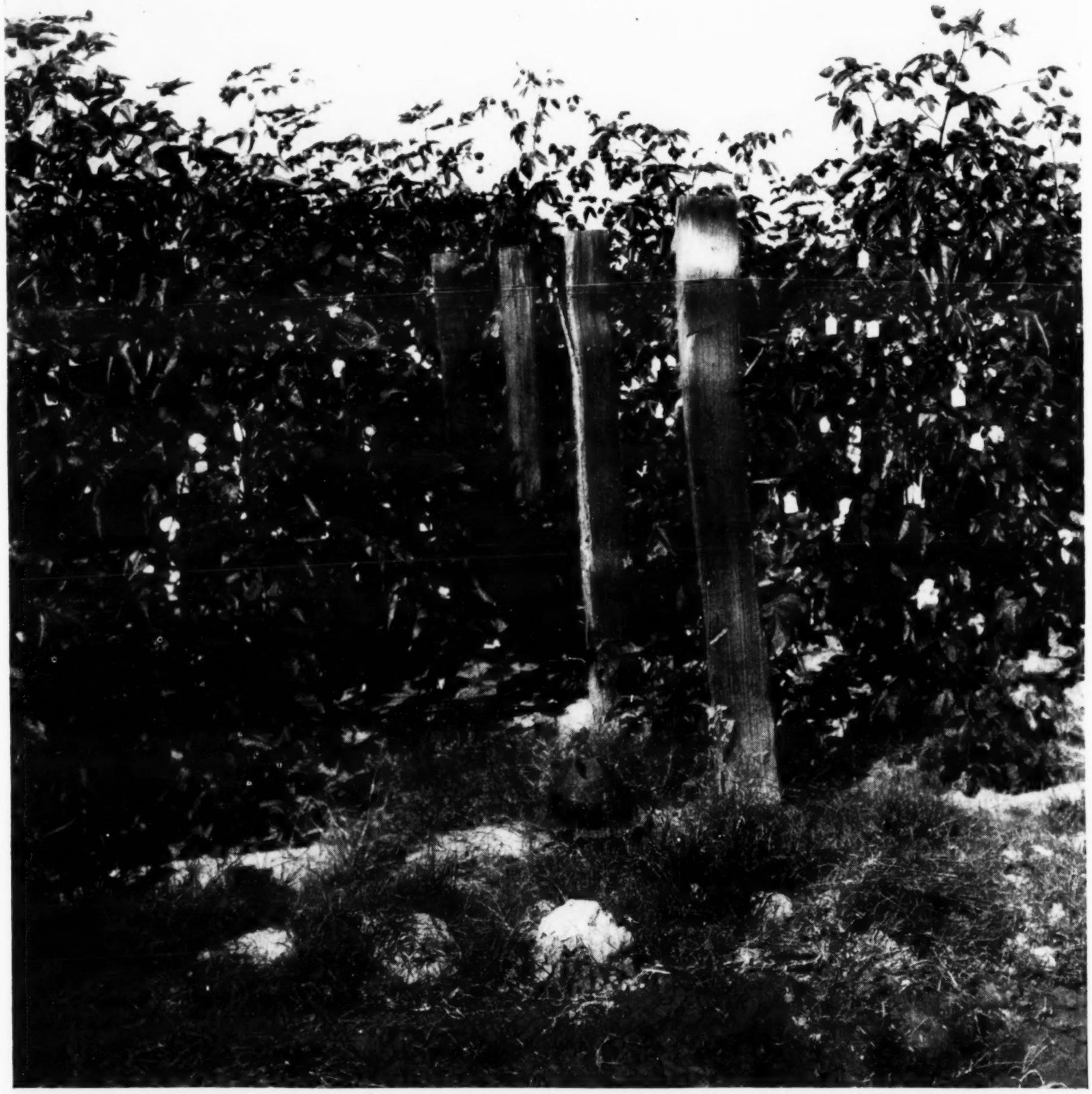
The new seedless plant (No. 10918) already obtained is being propagated as rapidly as possible. If the clon continues to show merit and hardiness, its distribution will be made first through The New York Fruit Testing Association for a general test of the behavior of the variety. Until such distribution is made plants will not be available.

A Corrected Date Seed Legend in June Journal

Through a blunder on the printer's part, the date seeds shown in Figure 6 of the June JOURNAL (p. 251) were wrongly labeled. The line of type along the margin of the picture was reversed, so that only the seeds in the center horizontal row were correctly designated. The correct designations are, beginning at the top: Roebellenii No. 1; C×R No. 9, Canariensis No. 6; Fard No. 4, and Mosque. The error is so glaring that readers of the JOURNAL who attempted to fit together legend and picture no doubt sensed that something was wrong, and it is hoped that the reference to the depression in the seeds produced by *Roebellenii* pollen may have given a clue to the difficulty. We very much regret that this first announcement in the JOURNAL of the newly discovered phenomenon of Metaxenia should have been marred by this error.

Mr. Nixon also calls attention to a less serious misstatement in the legend of Figure 2 of the same article (p. 244). Each of the long glassene bags, used in pollinating the date flowers, enclose *three* strands of the inflorescence, not *one* as stated in the legend.

—*Editor.*



TRELLISES FOR COTTON

Figure 11

Side view of a cotton breeding plot at the U. S. Field Station, Sacaton, Ariz., showing the trellis used for supporting the plants.

TRELLISING COTTON

A Convenient Method of Handling Breeding Plots

By George J. Harrison

END VIEW OF TRELLISED COTTON PLOT

Figure 12

Showing the braced posts at the end of the plot shown in Figure 11.

IN the irrigated valleys of the Southwest, cotton has a tendency to rank growth on the richer soils. This frequently results in the overturning of plants when high winds occur within a day or two following irrigation, and almost invariably the plants lodge and become badly tangled as the harvest season approaches. From the cotton breeder's standpoint, it is desirable to have good-sized individual plants in order to obtain sufficient seed to grow large progenies. It is also easier to compare the characters of large, well-grown plants with a view to selecting the best individuals for further propagation. In order to grow such plants, wide spacing is necessary. This, of course, increases the danger of lodging, and when the plants are down the labor involved in taking notes and harvesting the crop is greatly increased. A simple trellis consisting of a single strand of wire supported by fence posts has proven very satisfactory in eliminating this difficult in the Egyptian cotton breeding block at the U. S. Field Station, Sacaton, Arizona.

In addition to the advantages mentioned above, the trellis has proven successful in eliminating loss of plants by breakage. In previous years this has been a source of considerable damage, for naturally it is the larger, more fruitful plants that suffer most from being whipped about by the frequent summer storms and the high winds of two or three days' duration which sometimes occur in autumn. If breakage occurs before maturity, as is most often the case, it is likely to entail the loss of plants on which the breeder has expended much painstaking labor in self-pollinating or cross-pollinating flowers. Even though a plant escapes breakage, it is still susceptible to being

whipped about by high winds and this is often a source of much damage and waste of open bolls during the harvest season. This too, may result in the loss of the breeder's endeavor to secure sufficient seed from self-pollinated or cross-pollinated flowers, unless vigilant effort is maintained to keep the bolls picked as fast as they open.

All of the foregoing difficulties have been satisfactorily overcome by trellising. As a very striking example of how a trellis may prove beneficial, a flood which occurred at Sacaton in September, 1925, may be mentioned. At that time the breeding plots were flooded from 6 to 12 inches deep with swiftly flowing water for about 18 hours. This was a severe test, but every trellised plant remained erect, in marked contrast with the many plants in nearby fields that lay prostrate and partly covered with mud. The ground, under the rank growth of trellised cotton, remained wet for two weeks, yet there was no loss or damage by rotting of the bottom bolls.

The trellis in use (Figures 11 and 12) consists of 5 cedar* posts in each 240-foot row, spaced at intervals of 60 feet and set 2 feet in the ground, with the end posts strongly braced as in an ordinary fence. A single strand of galvanized wire, 12 gauge, is stretched tightly between the end posts and attached to the others by staples. Midway between the large posts are set stakes, 2 inches × 2 inches × 6 feet, which give additional support.

The wires are placed several inches below the tops of the plants so that the stems can be held up without injury to the tender terminal parts. Hard twine, 16 ply, firmly wrapped around the wire to prevent side slipping and with a generous loop around the stalk of the plant, suffices to hold the plant in position. Care must be exercised that the twine is not tied too tightly around the axis of the plant, as otherwise constriction will be caused by the increase in the diameter of the stalk, which weakens it at this point. This mistake was made at Sacaton the first season in which the trellis was used and a number of plants were broken by the wind.

In order that the ground may be prepared properly and the young plants cultivated, the trellis must be removed each winter and erected when needed the following summer. The time for erecting the trellis necessarily follows the last cultivation, when the cotton is "laid by." At Sacaton the latter part of July or the first of August has been found convenient, at which time the plants are about 4 feet high.

The following estimate of the cost of trellising is based on three years experience. The total cost of material sufficient for 28 rows 240 feet long, or about one half acre, was $78.40. The items are set forth below:

140	Cedar posts, roughly split, 6½ ft. long and about 5 in. square in cross section.
280†	Oregon pine stakes, 2 in. x 2 in. x 6 ft.
6,800 ft.	Galvanized wire, 12 gauge.
5 lb.	Poultry netting staples.

Estimating the cost of labor at $25.00, the total cost for the first year amounted to $103.40. However, the materials will last for a minimum of five years in Arizona, which makes the annual cost of trellising materials in this instance approximately $16.00, or about $32.00 per acre.

The saving in a single season in the labor of measuring plants, taking notes and harvesting the self-pollinated bolls, all of which must be done by trained men, much more than pays for the entire cost of installation.

*Cedar posts are preferable in this region as they suffer no injury from insects when in storage and also resist decay.

†Extra stakes were purchased as a reserve supply.

EDUCATION AND SIZE OF FAMILY*

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THE general decline in the birth-rate in America which has been going on for nearly a century has prompted a great deal of speculation and study as to causes. It has led to the study of birth-rates of specific groups, such as income groups, nationality groups, occupational groups, and educational groups. Among such studies the latter have occupied a conspicuous place. Most of these studies have been made with college alumni, and the results seem to have pointed to a high correlation between education and sterility. So widespread have these inferences been heralded that there is a general impression that education is toxic to fecundity.

Antagonists of higher education especially have seized upon these conclusions to bolster their case against the college. Churchmen, who are often anti-Malthusian, have denounced the educated groups as shirking their duty. Eugenic reformers have bemoaned the drying up of choicest blood streams and have launched their polemics not so much against the individuals as against the social order which gives rise to the situation.

But while a number of studies have been made of selected groups such as college alumni, very little has been done to show the relation between education and fecundity in the population at large. The well-known studies made of Wellesly, Vassar and Mt. Holyoke Colleges for women; of Harvard and Yale Universities for men; of Stanford and other co-educational universities, point unmistakably to the disproportionately low fecundity of college graduates, both men and women. The inference is that education is the dominant if not the sole cause. A number of studies made rather recently are tending to shift the emphasis. Banker[1] in his review of the data submitted by Holmes[2] on the size of college families, concludes that "it seems evident that if there is an educative factor involved in the problem of a declining birth-rate it is not operative through the higher institutions, but is chiefly effective in or below the high school," and a little further on in the same article says:

> It is the writer's opinion that education, and especially formal college education has little or nothing to do with the declining birthrate, that the correlations between education and fecundity which have been so greatly exploited are spurious or rather that they are simply mutual correlations with a tertium quid and are not directly related.

Banker also quotes from Brown and Greenwood in their study of "The Fertility of the English Middle Classes" the following conclusion of these writers:

> Paying attention to the errors of sampling, there is no difference between the average size of the family of a non-college mother and that of a college mother, which cannot be explained by difference of age at marriage and duration of marriage and the alleged prejudicial effects of higher education *per se* upon the capacity or inclination of women to bear children do not exist.

Woods[3] in a study of Harvard graduates finds on the other hand that there is a correlation between high achievement and big families. Only one-fourth as large a proportion of the celibates were represented in "*Who's Who*," as there were of those who had four or more children. Here again, however, the data comes from a very select group.

Griffing[4] in a study of "Education and Size of Family in China," more nearly approximates a population cross-section. His results are just contrary

*Collection of data made possible through cooperative aid furnished by the Division of Farm Population and Rural Life Studies, U. S. Bureau of Agricultural Economics.

to the findings of the American studies. "For the regions studied," he states, "education of parents results in increase rather than decrease in the number of living children. The groups from the highest cultural levels tend to leave the most survivors and reproduce substantially more than their own number."

In view of the fact that virtually all of the studies made on this question are confined to a selected group, and since certain students have suggested that the role of education in reducing fecundity has been over-emphasized to an extent not warranted by available facts, the material presented in this paper may be of interest.

The data were secured through the survey method from the homes in two Utah communities. The town of Ephraim has a population of slightly over 2,000, while American Fork has slightly over 3,000. Agriculture is the basic occupation in both, although all of the chief occupational divisions as used by the United States Census are represented. These towns are technically speaking, farm villages, but their size makes for a general distribution of their gainfully employed in all of the occupations necessary in communities of this size. In Utah, farmers dwell in the towns and go back and forth to and from their fields, so that they are town dwellers, just as are business and professional groups.

Every household in the communities was visited by a field investigator and a schedule was filled out for each family. This schedule called for a large number of items, including those which are used in this study. Age, highest grade completed in school, occupation, number of children born, number of children living, sex, etc., were among the items. In making the study herein reported we simply separated those parents who were 44 years or over.

The results for both towns and for both sexes are included in the accompanying correlation table. The sexes were tabulated separately at first but the results were so similar that they were combined in order to increase the size of the groups. The mean number of children for the male and female groups with no education, 1-4 elementary and college differed 0.3 to 0.4 of a child each and the 5-8 elementary and 1-4 high school were identical. The differences were not consistent.

The correlation secured (-.09) indicates that education has very little if any influence on the size of the families. This confirms the results of Brown and Greenwood on English Middle Classes.

If the figures in the table are arranged into the educational groups 0, 1-4 elementary, 5-8 elementary, high school, and college, the means are 5.3, 6.5, 6.2, 5.5, and 5.7 for the respective groups. This certainly does not indicate any tendency toward race suicide of the better educated individuals, and it is very probable that were the population of the upper two groups fully represented the differences would be even smaller than those given. A close study of the data will show that the elementary school groups are almost normal populations, whereas the others are more or less defective. The correlation table with adequate weighting is more likely to give the facts than are the means of the combined classes.

For the age group between 31 years and 43 years, where the family was still incomplete, those with elementary education only averaged about 4 children, and the high school and college groups, which were almost identical, were about 0.2 of a child less. The total number of individuals in these age groups was 578.

It seemed probable that part of the differences in size of families was due to occupational groups. In these towns the fathers over 44 years of age engaged in the professional occupations averaged about two years of college, the business men a little more than the seventh grade, the farmers between the sixth and seventh, and the laborors about the sixth grade. The mean children per male wage earner was 5.0 for the professional group, 6.0 for business

men, 6.3 for farmers and 5.7 for laborers. The professional group was too small to give reliable results, but the others seemed to be normal population samples. The family sizes do not group themselves according to the education of the workers, but according to the occupation. Except that in this study business men had larger families than laborers, our results with respect to the influence of occupation on size of family agree with those of Baber and Ross[5] in Wisconsin.

The results of Woods already noted respecting the size of families of the exceptionally vigorous men, suggested to us some statistics gathered by the questionnaire method from the leaders of the Mormon Church. These leaders (bishops and stake presidents) are chosen because of their ability from among members of the Church. They are successful farmers, business men, and representatives from all the other occupations. Their time is divided between their vocation and their position as Church leaders as they choose to divide it, the average time devoted to Church work being about 15 hours a week.

There were 382 of them who responded to the questionnaire and who were also over 44 years of age. Since almost all of these had received at least a full elementary education, only three groups are represented, the elementary, the high school, and the college. The results are given in table II.

It is seen from this that these exceptional men have had families which average one or more children than has the ordinary population shown in the correlation table. This is about what would be expected if this population acts similarly to the exceptional Harvard men studied by Woods.

In connection with these exceptional men, a study was made of the survival of the children born. The mean children alive for the three groups, beginning with the lowest, was 6.6, 6.3, and 5.5. That is, the percentage survival was 85.7, 86.3, and 88.7. This might be anticipated because of the difference in intelligence of these parents, but it is at variance with the results secured by Baber and Ross in Wisconsin, where it was found that among some of the higher educated individuals, the percentage of children who died was greater than for some of those with less education.

While the authors realize that the data herein presented are not comprehensive enough to warrant dogmatic statements, they feel that their results should bear as much if not more weight than statistics gathered from highly selected groups by means of the partial returns usually secured by the questionnaire method or from equally incomplete alumni records. The method employed in California, and reported by Holmes, of gathering information from each student registering for physical education gives a much more satisfactory sample from a select group than other methods, and Banker, in analyzing these results comes to the same conclusion that we do,—education is of minor importance in determining the size of the family. Vocation, social attitudes of the group, inherent physical vigor, economic considerations, and other factors far outweigh education. Whatever else our statistics may show, one thing is certain; the families of Utah, men and women, who have had higher education are not committing race suicide. Their families average about five children born and considerably over four and a half survive until after the parents are past the child bearing age.

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TABLE I—855 Utah Parents Arranged According to Amount of Education Received in School and Number of Children Born to Them, and the Coefficient of Correlation for the Two Parents

Degree of Schooling	No. of Children Born													Total
	0	1	2	3	4	5	6	7	8	9	10	11	12-over	
0	3	3	1	3	1	1	4	3	3		3	2		27
1						2		2	3		1			8
2	3			1		1		1	2		2	1	1	12
3	4	1	1	1	1	3	5	8	6	7	1	6	3	47
4	2	4	5		8	7	5	3	5	8	3		4	54
5	3	8	8	9	12	12	12	16	23	14	13	8	12	150
6	6		4	4	5	10	2	4	9	5	6	1	2	58
7	1	4	6	5	6	4	5	2	5	5	9	7	1	60
8	15	8	17	18	21	23	29	33	22	14	24	4	10	238
1 HS		3	6	10	4	10	15	4	7	12	1		1	73
2 HS	4	4	1	3	3	11	6	5	3	2	7	1		50
3 HS	1		3	1	3	1	5		3	3	1		1	22
4 HS		1	1	2	2	5	2	1						14
1 Col.			2	1		2	4					1	2	12
2 Col.			2		1	4	2			2	1		1	13
3 Col.		1			1	1								3
4 Col. & over			2	2	1	4	1		3	1				14
Total	42	37	59	60	69	101	97	82	94	73	72	31	38	855

Mean grade-- 7
Mean children-- 6.08
σ grade-- 3.04
σ children-- 3.19
r = .092 ± .019

TABLE II—Number of Children in Families of 382 Mormon Leaders More Than 44 Years Old

	Children														
Education	0	1	2	3	4	5	6	7	8	9	10	11	12-over	total	mean
0-8th Grade	7		3	4	15	7	13	24	18	17	20	4	27	159	7.7
H. S.	1	1	3	3	14	17	14	17	22	11	9	9	13	134	7.3
College	4	1	5	4	11	7	15	14	11	7	5	2	3	89	6.2
Total	12	2	11	11	40	31	42	55	51	35	34	15	43	382	7.2

A SPONTANEOUS TOMATO CHIMERA

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WHITE AND GREEN SEPALS

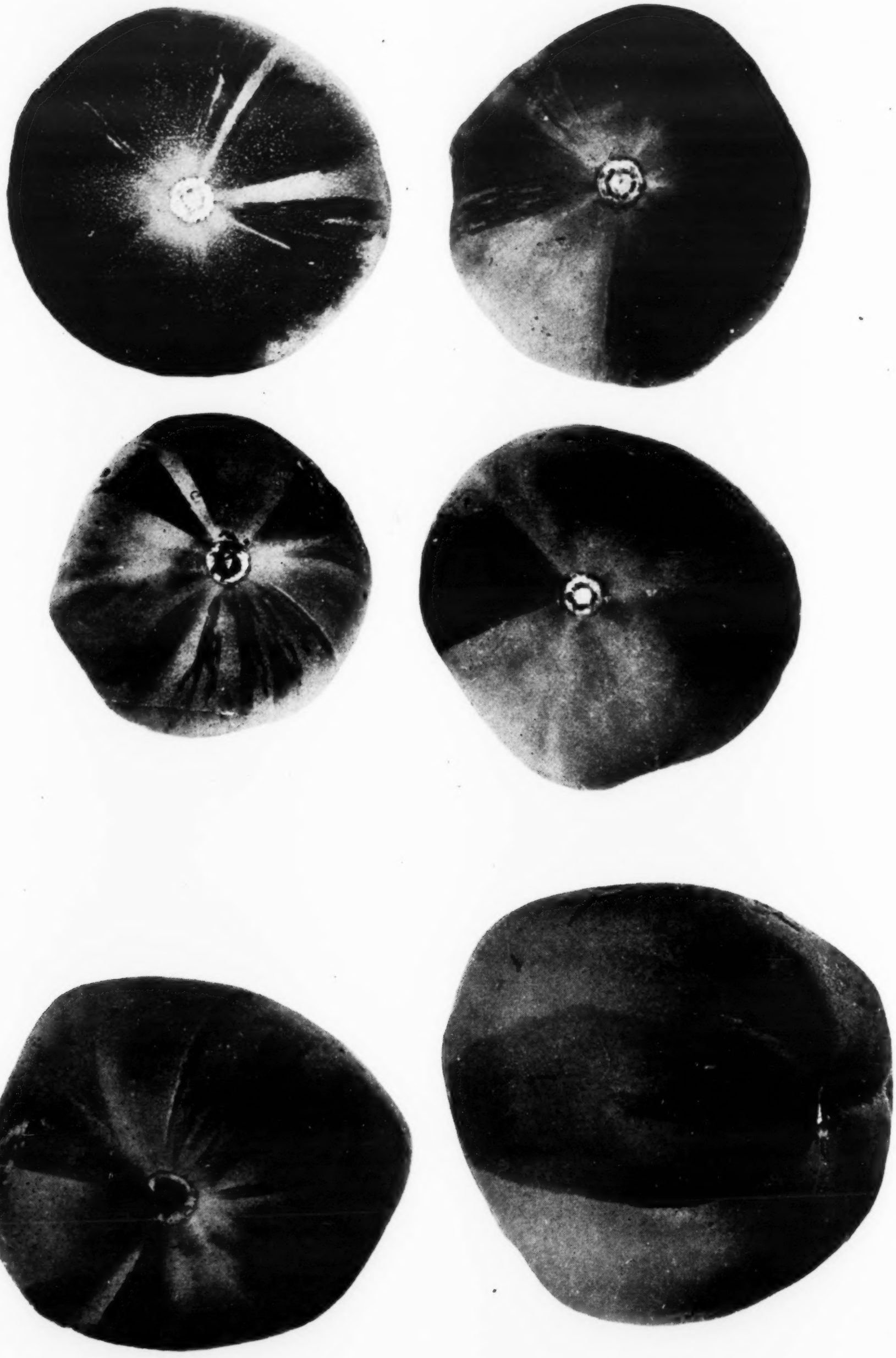
Figure 14

Chimeric sepals, inflorescence peduncle and fruit of tomato. The thicker green stripes are commonly raised in quite sharp relief along the stem, and are distributed in curious ways by splitting widening out, etc. White sepals shrivel very early.

PLANT Chimeras, bearing at least some parts made up by a more or less intimate admixture or intermingling of genetically different tissues, fall logically into two classes: (1) those—so frequent and well-known among the Solanums—that arise after two species have been artificially cross-grafted[1, 2]; and, (2) those—more rarely noted and less studied—that arise naturally and spontaneously from parts of one and the same plant, that have become different genetically, owing to some localized somatic or "bud" variation. One of the Solanums, the tomato, *Lycopersicum esculentum*, produces at least occasional chimeras of the latter class[3].

One such self-made or autogenous chimera, involving the chlorophyll pigments as so often happens, was observed in all stages of its formation on a tomato plant of known ancestry and genetic constitution. Two fully green varieties, Dwarf Aristocrat and Yellow Pear, both pure bred for five years and used in many crosses, when interbred produced normal green F_1 hybrids, and the selfed seed of a fruit of one of these yielded 294 F_2 seedlings, all normal at first; one, however, soon became exceptional by developing a strikingly pale yellowish-white foliage on one side set off sharply against the deep green of the other. The chlorophyll deficiency involved one *entire* small branch, leaves and stem alike, and extended thence as a deep band narrowing downward on the main stem to a distinct point slightly above the first node, where a somatic cell had presumably undergone some sort of permanent nuclear or cytoplasmic change.

The white branch outlined continued to differentiate only white secondary branches, foliage, sepals, and immature fruits, while the green portion remained normal, grew half again as



CHIMERIC TOMATOES

Figure 13

Green-and-white-striped fruits of tomato, illustrating a few of the multitude of varying patterns appearing in the different immature fruit clusters borne on the central and terminal portions of a plant that bud-sported. These fruits all ripened to a perfectly uniform red color. Photos taken with friuts submerged in water, to avoid light reflection spots. (Somewhat enlarged.)

SEEDLINGS FROM GREEN AND FROM WHITE FRUITS

Figure 15

Seedlings raised from fruits of green branches (right) and of white branches (left) of the same plant. The white or very pale green seedlings are so deficient in chlorophyll that they starve after forming the first few leaves. Could such frail plants be arch-grafted on to green host stocks, and be induced to develop new synthetic chimeras?

fast, and soon overspread the less vigorous mutated part. Green shoots never burst through on white branches; so these probably differ from the rather frequent bud mutations in the potato, which, it is claimed[4], alter the surface layers only, leaving the original parent tissue as the core of a periclinal chimera.

New apical buds from the junction zone between green and white tissue split throughout the season into: (a) all green shoots mostly towards the green side; (b) all white shoots mostly but not all adjacent the white side, and, (c) intermediate or terminal *chimeric* shoots with all varying proportions of intermixture of both green and white components. In such chimeric branches the stems, petioles, leaves, leaflets, peduncles, sepals, and "green" fruit Figures 13 and 14) displayed the two colors in juxtaposition and superposition, usually sharply distinct in longitudinal stripes, either deep (sectorial) or superficial (periclinal); each component apparently retained an unbroken continuity of cell lineage throughout the plant, but by branching and reuniting, broadening and narrowing, was distributed in curious ways according to the fortunes of growth. Leaflets were usually divided in or near the mid-line half green and half white, though some were light or dark grayish green from the periclinal arrangement of white and green layers. The white portions of the plant were evidently quite parasitic upon the green for rooted white cuttings failed to grow when severed from the main plant.

Flowers on all parts of the plant, unlike those of Norton's chimera[3], were normally fertile in both pollen and ovules. Whether selfed or crossed they

set readily and heavily with fruits that, as they ripened, rather suddenly lost any whiteness or chimeric striping they may have had, and assumed a uniform rich red color. It is interesting to note that neither the orange skin pigment, nor the red lycopersicin of the flesh, nor the purple anthocyanin of the stem and foliage was in any way affected by the variation that brought about the original chlorophyll deficiency.

The abundant seed was saved from all the branches separately, but an early frosty spell so damaged the plant, with the crossed fruits, and the cuttings in the field that they did not survive transplanting to the greenhouse. Through the seed it is hoped to be able yet to analyze the genetic nature of the bud variation that occurred; whether cytoplasmic or nuclear, and if nuclear, whether a chromosomal or a factor mutation. If the contrast is mendelian, then some one to four per cent naturally crossed hybrid seedlings would be expected; if white be recessive then a few green seedlings would be found among the whites, or a like proportion of populations reared from green seedlings would segregate with a green: white ratio; or, if white be dominant, then some whites should develop among the greed seedlings. Again if nondisjunction produced an unequal distribution of chromosomes this might be detected from root-tip chromosome counts.

So far the inheritance has proven exclusively maternal; green branches have produced all green seedlings; white branches all white seedlings, that live only long enough to put out a leaf of two—or many more in some sterile nutritive media (Figure 15). The chimeric fruits have produced either green or white, never as yet, any chimeric seedlings.

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